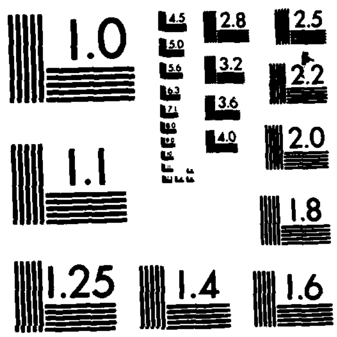
AD-A159 727 INSTALLATION RESTORATION PROGRAM PHASE II CONFIRMATION/QUANTIFICATION STA..(U) SCIENCE APPLICATIONS INTERNATIONAL CORP BELLEVE WA 1/3

UNCLASSIFIED R W GREILING ET AL 30 AUG 85 SAIC-85/1790 F/G 13/2 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

AD-A159 727

INSTALLATION RESTORATION
PROGRAM
PHASE II, STAGE 1
FINAL REPORT
GEORGE AFB, CA

DTIC FILE COPY

85 10 04 062

AD-A159 732

INSTALLATION RESTORATION PROGRAM
PHASE II —
CONFIRMATION/QUANTIFICATION
STAGE 1
FINAL REPORT
FOR
GEORGE AIR FORCE BASE, CALIFORNIA

TACTICAL AIR COMMAND
LANGLEY AFB, VIRGINIA

PREPARED FOR:

United States Air Force
Occupational and Environmental Health Laboratory (OEHL)
Brooks Air Force Base, Texas 78235

August 30, 1985

NOTICE

This Report has been prepared for the U.S. Air Force by Science Applications International Corporation for the purpose of aiding in the implementation of the Air Force Installation Restoration Program. It is not an endorsement of any product. The views expressed herein are those of the contractor and do not necessarily reflect the official views of the publishing agency, the United States Air Force or the Department of Defense.

Copies of this Report may be purchased from:

National Technical Information Service
5285 Port Royal Road
Springfield, Virginia 22161

Federal Government agencies and their contractors registered with Defense Technical Information Center should direct requests for copies of this report to:

Defense Technical Information Center
Cameron Station
Alexandria, Virginia 22314

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

AD-A159 727

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION
Unclassified

1b. RESTRICTIVE MARKINGS
None

2a. SECURITY CLASSIFICATION AUTHORITY
N/A

2b. DECLASSIFICATION/DOWNGRADING SCHEDULE
N/A

3. DISTRIBUTION/AVAILABILITY OF REPORT
Approved for Public Release
Distribution Unlimited

4. PERFORMING ORGANIZATION REPORT NUMBER(S)
SAIC-85/1790

5. MONITORING ORGANIZATION REPORT NUMBER(S)
N/A

6a. NAME OF PERFORMING ORGANIZATION
Science Applications International Corporation

6b. OFFICE SYMBOL (If applicable)
Loc. 168

7a. NAME OF MONITORING ORGANIZATION
USAF Occupational & Environmental Health Laboratory, Technical Services (OEHL/TS)

6c. ADDRESS (City, State and ZIP Code)
13400-B Northup Way, Suite 38
Bellevue, Washington 98005

7b. ADDRESS (City, State and ZIP Code)
Brooks AFB, Texas 78235-5000

8a. NAME OF FUNDING/SPONSORING ORGANIZATION
USAF OEHL

8b. OFFICE SYMBOL (If applicable)
TS

9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
F33615-80-D-4002, Delivery Order 46

8c. ADDRESS (City, State and ZIP Code)
Brooks AFB, Texas 78235-5000

10. SOURCE OF FUNDING NOS.

PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT NO.

11. TITLE (Include Security Classification) IRP Phase II Confirmation/Quantification at George AFB, CA

12. PERSONAL AUTHOR(S)
Richard W. Greiling and Robert L. Peshkin

13a. TYPE OF REPORT
Final

13b. TIME COVERED
FROM Sept 83 TO Feb 85

14. DATE OF REPORT (Yr., Mo., Day)
1985 August 30

15. PAGE COUNT
219

16. SUPPLEMENTARY NOTATION

fr BACK

17. COSATI CODES

FIELD	GROUP	SUB. GR.

18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
Groundwater Investigations, HARM, Hazardous Waste, IRP, Installation Restoration Program, George AFB, Victorville, Landfill Leachate.

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

An IRP Phase II, Stage 1 (Confirmation) The investigation was performed ~~at George AFB, California,~~ to determine if past waste disposal practices and spills of fuels and other materials may have impacted the environment or personnel health or safety. A field study was performed encompassing 17 of 23 disposal sites identified in the IRP Phase I Records Search as having the potential for contaminant release and impact. Field activities included a magnetic survey across four closed landfills, installation of 10 monitoring wells, soil and sediment sampling along roadways and drainage ditches, and testing of 3,000 feet of sewer line to determine the rates and locations of exfiltration.

Study findings suggest low-level contamination by chlorinated hydrocarbons, oils and greases, and possibly chromium and lead hydraulically downgradient of landfills and the major flight line industrial operations. Additional investigations should be carried out across the base

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT
UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT. ☐ DTIC USERS ☐

21. ABSTRACT SECURITY CLASSIFICATION
Unclassified

22a. NAME OF RESPONSIBLE INDIVIDUAL
Dennis D. Brownley, Major, USAF, BSC

22b. TELEPHONE NUMBER (Include Area Code)
(512) 536-2158

22c. OFFICE SYMBOL
USAF OEHL/TS

DD FORM 1473, 83 APR

EDITION OF 1 JAN 73 IS OBSOLETE.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

to confirm the extent and characteristics of contamination and to provide greater resolution as to the probable sources of pollutants prior to the development of remedial actions.

Key words:

FLD 19

INSTALLATION RESTORATION PROGRAM PHASE II — CONFIRMATION/QUANTIFICATION STAGE 1 FINAL REPORT FOR GEORGE AIR FORCE BASE, CALIFORNIA

TACTICAL AIR COMMAND LANGLEY AFB, VIRGINIA

August 30, 1985

PREPARED BY:

Science Applications International Corporation
13400-B Northup Way, Suite 38
Bellevue, Washington 98005

Contract No. F33615-80-D-4002

Dennis D. Brownley, Major, USAF, BSC
Technical Program Manager
Technical Services Division (TS)

PREPARED FOR:

United States Air Force
Occupational and Environmental Health Laboratory (OEHL)
Brooks Air Force Base, Texas 78235

NOTICE

This Report has been prepared for the U.S. Air Force by Science Applications International Corporation for the purpose of aiding in the implementation of the Air Force Installation Restoration Program. It is not an endorsement of any product. The views expressed herein are those of the contractor and do not necessarily reflect the official views of the publishing agency, the United States Air Force or the Department of Defense.

Copies of this Report may be purchased from:

National Technical Information Service
5285 Port Royal Road
Springfield, Virginia 22161

Federal Government agencies and their contractors registered with Defense Technical Information Center should direct requests for copies of this report to:

Defense Technical Information Center
Cameron Station
Alexandria, Virginia 22314

PREFACE

Science Applications International Corporation (SAIC), has performed this IRP Phase II, Stage 1 (Confirmation) Investigation under Delivery Order 46 of Air Force Contract No. F33615-80-D-4002. The purpose of this investigation is to determine if environmental contamination has resulted from past hazardous waste disposal practices, fuel spills, and industrial waste discharges at George AFB, California. Richard W. Greiling, P.E. served as the SAIC project manager and John Meade as the contracts manager. John Musser, Bob Peshkin, Patt O'Flaherty, and Glynda Steiner assisted in the field program and data interpretations, and Linda Wynands, J. Peter Dye, and Kim Spencer assisted in report production.

The field and analytical program was accomplished between December 1983 and August 1984. Major Dennis D. Brownley, Technical Services Division, USAF Occupational and Environmental Health Laboratory (USAF OEHL) was the technical monitor.

TABLE OF CONTENTS

Table of Contents

(cont'd)

Table of Contents
(cont'd)

LIST OF TABLES

LIST OF FIGURES

List of Figures
(cont'd)

EXECUTIVE SUMMARY

This report presents the results of the Phase II, Stage 1 (Confirmation) Investigations performed at George Air Force Base, California in accordance with the U.S. Air Force Installation Restoration Program (IRP). The investigations were performed to confirm or deny the presence or release of hazardous wastes from past waste disposal practices identified during the IRP Phase I records search conducted earlier by the USAF. The Phase II field investigations were initiated to: (1) determine if there had been a release of PCB contaminated oils in the central maintenance area; (2) confirm the release of petroleum residuals or hazardous chemicals from unsecured landfills and spill sites in the northeast and southeast corners of the base; (3) determine whether waste-fuels discharges to roadway surfaces and a storm water drainage arroyo had impacted the environment; (4) confirm the presence or absence of suspected perforated pipe sections in a major industrial and flightline stormwater drain line; and (5) review and evaluate liquid fuels supply and systems maintenance records.

A magnetometer survey was performed across approximately two million square feet of abandoned landfill surface to identify the probable locations of suspected buried drums containing waste liquid organics. These results were used to establish the location of three groundwater monitoring wells in the southeast landfill area. A total of ten monitoring wells were developed across the entire base, eight using hollow stem auger drilling techniques and two wells installed by mud-rotary drilling. Shallow surface borings were taken within the principal drainage arroyo, and roadway soils were excavated to determine the degree of contamination from past fuel disposal practices.

The IRP Phase II, Stage 1 investigations have confirmed that local groundwater surface elevations are 110 to 160 feet below the ground surface, and that what may be a continuous lens of tight sandy clay extends across the base approximately 60 to 70 feet below the ground surface. Groundwater flow has been demonstrated to move in a northeast direction with a calculated horizontal velocity of approximately 0.25 feet per day.

The suite of chemical characterizations performed on soil and groundwater samples indicates the presence of trace organic and heavy metal contaminants at concentrations exceeding current drinking water criteria. There appears, however, to be no appreciable environmental degradation to the land surface and no known public health or safety concerns at this time. Measurable quantities of oil and grease, and of chlorinated hydrocarbons, were found in nearly all wells sampled. In some instances, what appear to be contaminant gradients may be indicative of pollutant sources. Measurable chromium and lead concentrations in groundwater samples indicate one of three possible situations: (1) groundwater contamination of anthropogenic origin, (2) naturally-occurring metal cations bound to particulates in the water sample, or (3) a consequence of drilling mud residuals within the well casing or annulus (as in the case of Wells NZ02 and NZ03 located downgradient of the northeast landfill and constructed using mud rotary drilling techniques). Additional sampling of all monitoring wells should be accomplished to confirm the presence and establish the origin of measurable oil and greases, halogenated hydrocarbons, and heavy metal contaminants. No polychlorinated biphenyls were present in either soils or groundwater collected in the central disposal area.

The industrial/storm drain fronting the aircraft operational apron was determined to experience extensive exfiltration in at least 1,153 feet of the total length of line tested. It is probable this segment of 12-inch diameter corrogated metal pipe is perforated most if not all of its length. Lower rates of exfiltration in the 10-, 15- and 18-inch diameter drain lines suggest that water loss occurred primarily through pipe joints and/or lesser lineal footage of perforated lines. Field observations noted during the exfiltration tests confirmed that flightline and operational apron runoff and/or fuel spills have resulted in the accumulation of fuel-enriched silt and debris in the drain line. A review of liqui' fuels management activities discovered that at least three JP-4 fuel laterals in the immediate vicinity of the industrial/storm drain line were reported as leaking fuel in late 1983. These lines were closed and remain out of service. No excavations below the operational apron have yet been undertaken to determine the extent of fuel loss or migration.

An IRP Phase II, Stage 2 (Confirmation) Investigation is recommended for purposes of replicating most of the sampling done to date, and to perform additional tests in site specific areas which may be contributing to chronic low

level pollution in several areas of the base. The highlights of the recommended Stage 2 site investigations include:

- Three sampling events of all existing groundwater monitoring wells in the northeast, central, and southeast disposal areas for the quantification of dissolved heavy metals, chlorinated hydrocarbons, pH, specific conductance, total organic carbon, and, in selected instances, phenols and PCBs.

- The construction of numerous soil borings along the length of the industrial/storm drain (Site S-20) and around the periphery of the operational apron to determine the amount and extent of contamination by aromatic and aliphatic hydrocarbons and heavy metals. Sediments in the bottom of the storm drain should be chemically characterized.

- Chemical analyses of soil samples taken within and above known areas of fuel spills that drain into the northeast drainage arroyo (Site S-20). The sampling program is designed to extend into the base housing area to characterize nonpoint, nonindustrial soil contaminant burdens.

- Reconnaissance sampling of soils beneath the old treatment plant sludge drying beds (Site S-25) and around the periphery of the current fire training area (Site S-5) to determine if heavy metal or hydrocarbon contamination is present and mobilizing.

- Remote sensing of the southeast landfills (Sites L-1 through L-4) to determine the presence and location of containerized waste liquid solvents. Additional installation of groundwater monitoring wells is recommended if existing wells continue to yield chlorinated hydrocarbon contamination and if remote sensing techniques identify potential burial sites of the waste solvents.

- Construction of soil gas monitoring stations along the pressurized liquid fuels distribution system.

- Replication of roadway sediment sampling along the West Perimeter Road (Site S-4) and characterization for aromatic and aliphatic hydrocarbons and heavy metals. This sampling should also be extended onto the interior road leading to the jet engine test cell.

These additional studies could be completed in approximately 6 months time, at which point site specific remedial plans can be developed and evaluated against a number of criteria including: effectiveness in eliminating a source, mitigating resource damage, cost, regulatory requirements, and implementability.

1.0 INTRODUCTION

1.1 THE INSTALLATION RESTORATION PROGRAM

The U.S. Air Force, due to its primary mission of defense of the United States, has long been engaged in a wide variety of operations dealing with toxic and hazardous materials. This problem has been recognized by the Department of Defense (DoD) and action has been taken to identify the locations and contents of past disposal sites and eliminate the hazards to public health in an environmentally responsible manner. The DoD program is called the Installation Restoration Program (IRP). The current IRP policy is contained in Defense Environmental Quality Program Policy Memorandum (DEQPPM) 81-5, dated 11 December 1981, and implemented by Air Force message 211807Z January 1982. The IRP is defined in DEQPPM 81-5 as a four-phased program that is designed to ensure that identification, confirmation/quantification, and remedial actions are performed in a timely and cost-effective manner. The initial IRP guidance was developed and published in June 1982. This document included in-depth guidance for Phase I, concept guidance for Phase II, and general guidance for Phases III and IV. The management concept for Phase II was updated by the Air Force Engineering Services Center (AFESC) in May 1982. Each phase, briefly described, and its relationship to the overall program are:

1. Phase I - Installation's Assessment (Records Search) - Phase I is the responsibility of the USAF's Engineering and Services Center. Its purpose is to identify and rank by degree of concern those past disposal sites that may pose a hazard to public health or the environment as a result of contaminant migration to surface or groundwaters. In this phase, it is determined whether a site requires further action to confirm an environmental hazard or whether it may be considered to present no hazard at this time. If a site requires immediate remedial action, such as removal of abandoned drums, the action can proceed directly to Phase IV. Phase I is a basic background document for the Phase II study.

2. Phase II - Confirmation/Quantification - Phase II is the responsibility of the USAF's Occupational and Environmental Health Laboratory (OEHL). The purpose of this phase is to define and quantify, by preliminary and comprehensive environmental and/or ecological survey, the presence or absence of contamination, the extent of contamination, waste characterization (when required by the regulatory agency), and identify sites or locations where remedial action is required. Research requirements identified during this phase will be directed to AFESC for inclusion in

the Phase III effort of the program. Needs for contaminant health standards will be identified to the Command Surgeon for resolution.

3. Phase III - Technical Base Development - This phase is the responsibility of the USAF's Engineering and Services Center, and its purpose is to develop a sound data base upon which to prepare a comprehensive remedial action plan. This phase includes implementation of research requirements and technology for objective assessment of adverse effects. A Phase III requirement can be identified at any time during the program.

4. Phase IV - Operations/Remedial Actions - This phase is the responsibility of the USAF's Engineering and Services Center and includes the preparation and implementation of the remedial action plan.

1.2 BASE MISSION

George AFB, formerly known as Victorville Army Airfield, is located on 5,347 acres of land in the Mojave Desert region near Victorville, California (Figure 1). It was proposed as an advanced flying school on a site originally comprised of approximately 2,200 acres of land. Construction of the facility began in 1941 and was completed in 1943. The Los Angeles District of the U.S. Engineer Department (Corps of Engineers) and the Third District Regional Office, San Bernardino, designed and supervised its construction.

Advanced twin-engine pilot and bombadier training using five types of aircraft started in 1942 before construction was complete. Before the end of World War II, the airfield was also used for glider pilot, pilot, and bombadier training on as many as 13 different aircraft as large as and including the B-25 bomber. The training mission ended at the end of the war, all flying operations ceased, and the base was placed on standby status. In late 1945 it was assigned to the Air Technical Service Command and used to store aircraft, at one time including more than 700 B-29 bombers.

In mid-1950 the base was renamed in honor of Brig. General Harold H. George, a World War I fighter ace. In July of that same year, the F-86-equipped 1st Fighter Interceptor Wing moved to the high desert base. Several wings staged through George to train in the F-86 prior to deploying to Korea.

Tactical Air Command took over the base on November 15, 1951, with the 131st and 146th Fighter Bomber Wings flying F-51 Mustangs. The 1st Fighter

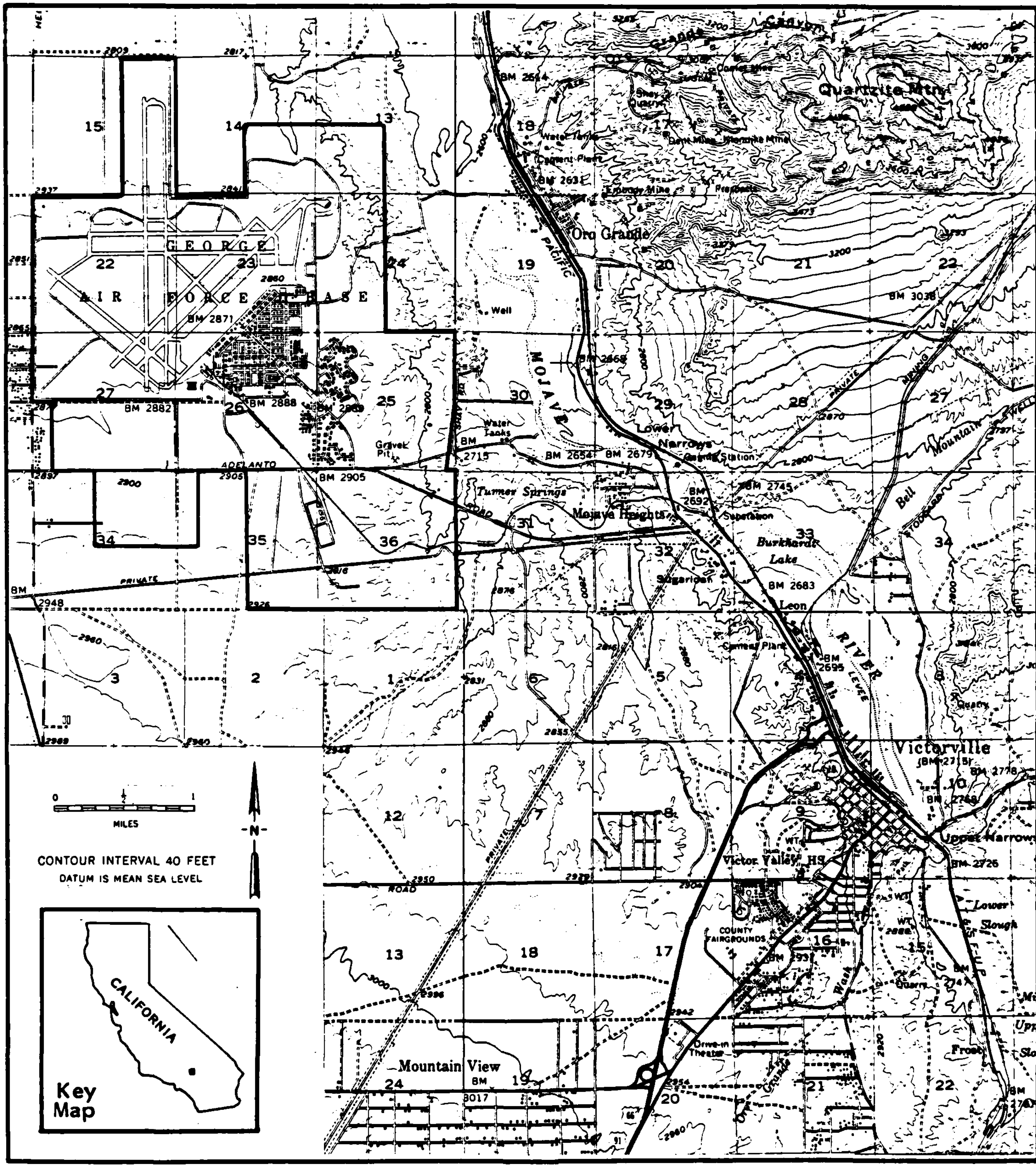


Figure 1

LOCATION MAP OF GEORGE AIR FORCE BASE AND VICTORVILLE, CALIFORNIA

Source Map: USGS Victorville Quadrangle, 15' Series, 1956.

Interceptor Wing moved to Norton AFB, leaving the 94th Fighter Interceptor Squadron at George to fly the F-86 in the air defense role. In January 1953, the 479th Fighter Bomber Wing absorbed the 131st FBW mission and became the host unit. The 479th became the first TAC wing to become operational in the new supersonic F-100 Super Sabre in September 1954. Four years later, in July 1958, the F-104 Starfighter was added to its inventory. The following year, 1959, the F-100D-equipped 31st Tactical Fighter Wing was activated at George. That wing was reassigned to Homestead AFB, Florida, in May 1962.

While the 479th continued to train pilots to fly the F-100 and F-104, yet another wing was activated at George, this time to train combat readiness in the new F-4C Phantom tactical fighter. Activated as the 32nd TFW, the 8th left for Ubon AB, Thailand, after achieving combat-ready status.

The 479th TFW got its first F-4C Phantoms in November 1964 and became an all-phantom wing in June 1967 when the last of the F-104s left George. Also during the early 1960s, ADCOM's 329th Fighter Interceptor Squadron flying F-106 Delta Darts was based at George. During the same part of the early 1960s, the F-105D Thunderchief-equipped 355th TFW was activated at the base. The wing was transferred to McConnel AFB, Kansas, in July 1964.

On October 1, 1971, the 35th TFW was transferred from Phan Rang AB, Vietnam, to replace the now inactivated 479th TFW. The George AFB mission continued to be one of training pilots to fly the F-4. In 1973 the wing gained the F-105G Wild Weasel mission upon its transfer from McConnel AFB, Kansas, and in the spring of 1975, George AFB became the "Home of the Wild Weasels," as F-105G and F-4C WW training transferred to George from the Fighter Weapons School at Nellis AFB, Nevada.

George AFB is presently the host of the 831st Air Division. The primary mission of the division is to execute tactical fighter operations and to provide training for aircrew and maintenance personnel. The 35th Tactical Training Wing, a major component of the Division, consists of the following squadrons:

- 20th Tactical Fighter Training Squadron - provides flight and academic training to German Air Force crews

- 3rd German Air Force Training Squadron - assists in the welfare of German Armed Forces personnel
- 21st Tactical Fighter Training Squadron - provides combat training for F-4E aircrews
- 35th Aircraft Generation Squadron
- 35th Equipment Maintenance Squadron
- 35th Component Repair Squadron

The 37th Tactical Fighter Wing, another component of the division, consists of the following:

- 561st Tactical Fighter Squadron - active F-4G combat squadron
- 562nd Tactical Fighter Training Squadron - provides combat training for F-4E aircrews
- 563rd Tactical Fighter Squadron - active F-4G combat squadron
- 37th Aircraft Generation Squadron
- 37th Equipment Maintenance Squadron
- 37th Component Repair Squadron

Mission support is provided by the following units:

- Resource Management
- Comptroller
- Contracting Division
- 27th Tactical Air Support Squadron
- 831st Combat Support Group
- 831st Supply Squadron
- 831st Civil Engineering Squadron
- 831st Security Police Squadron
- 831st Services Squadron
- 831st Transportation Squadron
- Field Training Detachment 516
- 2067th Information Systems Squadron
- Detachment 12, 25th Weather Squadron
- Detachment 5, 4400 Management Engineering Squadron
- Air Force Audit Agency

1.3 THE INSTALLATION RESTORATION PROGRAM AT GEORGE AIR FORCE BASE

The IRP Phase I records search for George Air Force Base, California was performed under contract by the consulting firm of CH2M HILL. The Phase I records search was initiated in September, 1981, and the report was available for release in January, 1982. These activities included a detailed review of pertinent installation records, contacts with 23 local and regulatory agencies which were known or suspected to have documents containing relevant information, and interviews with 36 former and present base personnel. A review of past and present industrial operations was obtained through available shop files, real property files, and historical records, photographs and maps.

Next to be considered was a review of the past and present management practices for landfill areas, dump sites, hazardous wastes, and accidental spills. The identification of landfill and other solid or liquid waste disposal and burial sites, solvent and fuel storage and disposal sites, and spills and leaks was the goal of this management protocol.

Once potential sites had been identified and inventoried by records search or verbal contact with personnel, a ground survey of specific sites was undertaken to observe the obvious signs of environmental stress (leachate, fuel stains, etc.) on the installation. All identified and surveyed sites were catalogued and designated on maps. Geomorphology, drainage, soil condition, hydrology, local meteorology and geology were carefully considered at each site.

A site evaluation rating was performed to quantify and rank, by environmental health risk priority, each site where there existed a potential for hazardous waste release. This rating evaluation system was developed by DoD and is called the Hazardous Assessment Rating Methodology (HARM). Like the other hazardous waste site ranking models, the HARM model uses a scoring form to rank sites for priority attention. The model uses data obtained during the record search portion (Phase I) of the IRP. In assessing the hazards at a given site, the model develops a score based on four aspects of the hazard posed by a specific site: (1) the possible receptors of the contamination; (2) the waste and its characteristics; (3) potential pathways for contaminant

migration; and (4) any efforts to contain the contaminants. Each of these categories contains a number of rating factors that are used in the overall hazard rating.

Table 1 is a summary of 54 sites which were identified during the IRP Phase I records searches and investigated for potential contamination and migration hazard. Thirty-one of the sites were found not to be a potential threat to the environment or public health and safety in context of regulated hazardous wastes and were not evaluated using the HARM rating model. The remaining 23 sites were ranked using the HARM model. The sites and their HARM total scores and subscores are identified in Table 2.

At the conclusion of the IRP Phase I records search, the USAF determined the potential for off-site migration of hazardous wastes at George AFB is low because of the relatively low groundwater levels, negative net annual precipitation, and the absence of surface waters. Six of the HARM rated sites were determined as having low or nonexistent environmental, public health or safety concerns. As a consequence, Phase II funds were not appropriated to perform comprehensive site investigations. These six sites include Site B-2, a reported 1952 burial site of up to 400 gallons of lead-based paints near Air Base Road and the skeet range. Sites S-1 and S-3 are small abandoned waste oil and fuel leach pits behind vehicle maintenance buildings and the fuels lab. Site S-5 is the current fire training area north of Crosswind Runway 21, while Site S-7 is the old wing tip fuel tank drainage area near the operations apron. Removal of fuel-enriched soils in affected areas, particularly at Site S-7, has been undertaken in the past. Finally, Site S-12 is the base golf course which for several years was irrigated with effluent from the wastewater treatment plant. There have been no observed detrimental effects to the golf course or downslope vegetation or of base water supply groundwater quality as a consequence of golf course irrigation with plant effluent. Golf course irrigation is accomplished solely with groundwater now that all wastewaters are transported off-base to the Victor Valley Regional Wastewater Treatment Plant.

The HARM ratings of the remaining 17 sites indicated many have a moderate to high potential for contaminant release or migration. In addition, possible

Table 1

DISPOSAL SITE PRELIMINARY ENVIRONMENTAL SUMMARY GEORGE AFB, CALIFORNIA

Site	Waste Type	Potential Hazards: Contamination	Potential Hazards: Migration	Numerical Rating Assigned
Munitions				
M-1	Small Arms Residue	YES	NO	NO
M-2	Small Arms Residue/Oil	YES	YES	YES
M-3	Small Arms Residue/Bombs	YES	NO	NO
Landfills				
L-1	Industrial/Domestic	YES	YES	YES
L-2	Fuel Tank Sludge	YES	YES	YES
L-3	Radioactive/Toxic	YES	YES	YES
L-4	Starter Cartridges	YES	NO	NO
L-5	Paper	NO	N/A	NO
L-6	Debris/Possible Asbestos	YES	NO	NO
L-7	Construction Debris	NO	N/A	NO
L-8	Construction Debris	NO	N/A	NO
L-9	Domestic	NO	N/A	NO
L-10	Debris/Domestic	NO	N/A	NO
L-11	Debris/Domestic/Industrial	YES	YES	YES
L-12	Industrial/Domestic	YES	YES	YES
L-13	Industrial/Domestic	YES	YES	YES
Other Dumps				
B-1	Chemical Toilet Residue	NO	N/A	NO
B-2	Paint	YES	YES	YES
B-3	Debris/Industrial	NO	N/A	NO
B-4	Debris/Industrial	NO	N/A	NO
B-5	Rubble	NO	N/A	NO
B-6	Rubble/Domestic	NO	N/A	NO
B-7	Construction Debris	NO	N/A	NO
B-8	Pesticides/Paint	YES	YES	YES
B-9	Acids/Oils	YES	YES	YES
B-10	Pesticides/Oils	YES	YES	YES
B-11	Aircraft	NO	N/A	NO
B-12	Aircraft Parts	YES	NO	NO
B-13	Possible Munitions	YES	NO	NO
Liquid Disposal or Spills				
S-1	POL	YES	YES	YES
S-2	Sanitary	NO	N/A	NO
S-3	POL	YES	YES	YES
S-4	Jet Fuel	YES	YES	YES
S-5	POL	YES	YES	YES
S-6	POL	YES	YES	YES
S-7	Jet Fuel	YES	YES	YES
S-8	Jet Fuel	YES	NO	NO
S-9	Creosote	YES	NO	NO
S-10	Jet Fuel	YES	NO	NO
S-11	Jet Fuel	YES	NO	NO
S-12	STP Effluent	YES	YES	YES
S-13	Jet Fuel	YES	NO	NO
S-14	Jet Fuel	YES	NO	NO
S-15	Jet Fuel	YES	NO	NO
S-16	Leaded Gas	YES	NO	NO
S-17	Jet Fuel	YES	NO	NO
S-18	Solvents/Oils	YES	NO	NO
S-19	Transformer Oils	YES	NO	NO
S-20	Industrial	YES	YES	YES
S-21	Sanitary/Industrial	YES	YES	YES
S-22	POL	YES	YES	YES
S-23	Jet Fuel	YES	YES	YES
S-24	Sanitary/Industrial Sludge	YES	NO	NO
S-25	Sanitary/Industrial Sludge	YES	YES	YES

Source: IRP Phase I Report prepared by CH2M HILL (1982)

Table 2

SUMMARY OF HARM SCORES FOR
POTENTIAL HAZARDOUS WASTE DISPOSAL SITES
GEORGE AFB, CALIFORNIA

Site	Site Description (weighting factor)	Receptors 0.22	Pathways 0.30	Waste Characteristic 0.24	Waste Management Practices 0.24	Overall Score (weighted avg.)
		Subscores (% of Maximum Possible Score in Each Category)				
Munitions						
M-2	Munitions Disposal	22	16	60	57	38
Landfills						
L-1	Base Landfill	33	18	80	72	50
L-2	TEL Disposal Site	22	19	80	62	45
L-3	Radioactive Disposal	22	14	60	53	36
L-11	Street Sweeping Disposal	30	18	70	46	40
L-12	Original Base Landfill	27	12	70	64	42
L-13	Base Landfill	27	22	80	71	49
Burial Sites						
B-2	Paint Drum Burial	31	12	50	57	36
B-8	Pesticide and Paint Burial	24	16	50	57	36
B-9	Acid and Oil Burial	24	16	50	61	37
B-10	Pesticide and Oil Burial	24	16	50	57	36
Liquid Disposal or Spills						
S-1	POL Leach Field	33	12	50	48	34
S-3	POL Leach Field	33	12	50	48	34
S-4	Fuel and Oil Disposal	20	14	80	65	44
S-5	Fire Training Area	31	19	80	65	47
S-6	Abandoned Fire Training	27	21	80	65	47
S-7	Tip Tank Drainage Area	33	17	80	57	45
S-12	Golf Course/WWTP Irrigation	61	16	50	62	45
S-20	Industrial Outfall & Pipeline	37	34	100	74	60
S-21	STP Percolation Ponds	27	30	60	74	47
S-22	French Drain	33	14	80	48	42
S-23	French Drain	33	14	70	48	40
S-25	Sludge Drying Beds	27	16	60	73	43

Source: IRP Phase I Report prepared by CH2M HILL (1982).

additive effects may result from combined contaminant migration because in some areas the sites are close together. As a result, five general areas were identified as having the highest potential for pollutant migration. These areas, identified on Figure 2, contain 17 of the sites rated for HARM score and two sites (L-4 and S-19) which had not been ranked. Presented in order of priority, these five areas are:

1. Industrial/Storm drain line and Outfall, (Site No. S-20).

2. Northeast Disposal Area - STP percolation ponds (S-21), the most recent base landfill (L-13), the abandoned fire training area (S-6), the sludge drying beds (S-25), the original base landfill (L-12), the street sweeping disposal area (L-11), and the three unverified acid, oil, paint, and pesticide burial sites (B-8, B-9, B-10).

3. Southeast Disposal Area - major base landfill (L-1), the tetra-ethyllead disposal site (L-2), the radioactive/toxic chemical disposal site (L-3), the starter cartridge disposal area (L-4), and the munitions disposal site (M-2).

4. Central Disposal Area - leaking transformer oils (S-19), dry well used for waste POL disposal (S-22), and dry well used for waste jet fuel disposal (S-23).

5. West Perimeter Road waste jet fuel disposal area (S-4) - the lineal extent of the fuel disposal area is uncertain, and may have included a second interior road leading to Engine Test Cell 799.

The USAF Occupational and Environmental Health Laboratory (OEHL) retained JRB Associates, division of Science Applications International Corporation (SAIC) in September 1983 to perform an Installation Restoration Program Phase II confirmation/quantification investigation at George AFB using funding provided by the United States Air Force. Field work commenced in December 1983 in reponse to the recommendations of the IRP Phase I report. This work included the installation of 10 groundwater monitoring wells in the northeast, central, and southeast disposal areas; collection of composite soil samples from seven 10-foot borings in the industrial outfall ditch; collection of two soil samples from the roadway at the west perimeter road spill site; performance of an exfiltration test to locate perforated drain intervals along the industrial pipeline beneath the flightline operational apron; and review of USAF pressure test data for the George AFB Liquid Fuels System. Borehole soil samples and groundwater samples were collected from all of the monitoring wells.

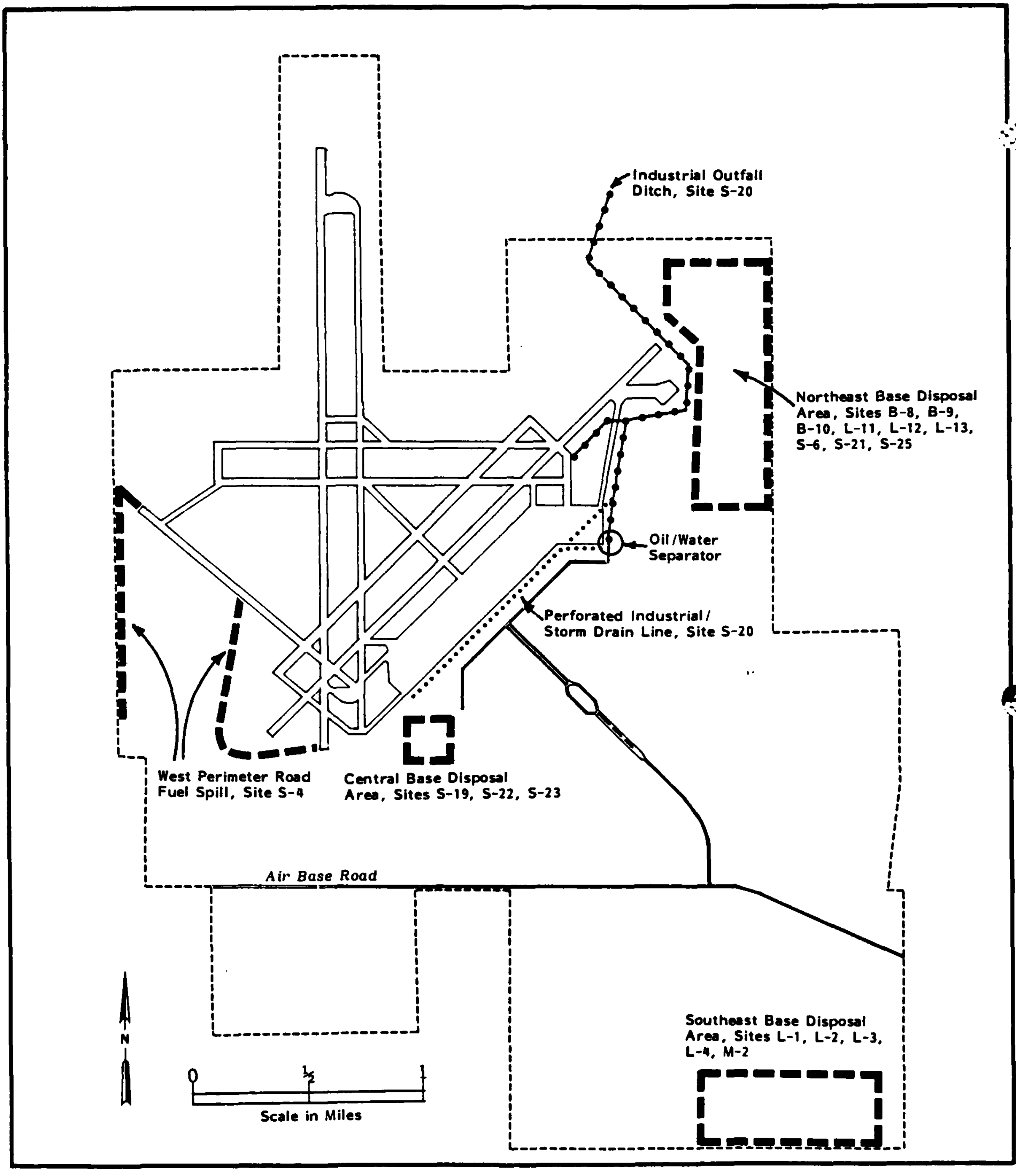


Figure 2

LOCATION MAP OF POTENTIAL HAZARDOUS WASTE DISPOSAL SITES*
SURVEYED DURING IRP PHASE II CONFIRMATION INVESTIGATION
AT GEORGE AIR FORCE BASE

*As identified in IRP Phase I Report, CH2M HILL (1982).

Groundwater samples taken from wells in the northeast and southeast disposal areas were analyzed for oils and greases, phenols, total organic carbon, chromium, lead, silver, purgeable aromatics, purgeable halocarbons, DDT and chlordane. These analytes were selected because of known or suspected waste types buried in the landfills or, in the case of the northeast disposal area, because of conservative pollutant types (e.g., heavy metals) known to be in wastewater treatment plant effluents that were disposed in percolation ponds for more than 30 years. Water samples taken from the central disposal area monitoring wells were analyzed for oils and greases, total organic carbon, and polychlorinated biphenyls. These analytes were selected because of the known transformer oil spills and dry well disposal of waste fuels.

Surface and/or shallow soil samples taken along the west perimeter road and in the industrial/storm outfall ditch were analyzed for oil and grease content to measure possible hydrocarbon contamination resulting from past disposal practices. Finally, nine soil samples were selected from those taken during borehole drilling based on organic vapor analyzer readouts or soil types that suggested possible contamination. These soils were analyzed to determine the concentrations of oils and greases, phenols, chromium, lead, silver, chlorinated pesticides, and halocarbons. All field measurements and analytical data are presented in the following sections of this report and were used in the development of remedial actions for follow-on investigation and confirmation.

1.4 IDENTIFICATION OF THE FIELD TEAM

The George AFB Phase II (Confirmation) Investigation was performed by Science Applications International Corporation. Geophysical field and technical support was provided by John M. Musser of Geo-Recon International of Seattle, Washington. Eight of the Phase II well borings were drilled using hollow stem auger techniques by Stang Hydronics of Orange, California, while Pioneer Drilling of Redlands, California drilled two wells using mud rotary techniques. Sediment and water analyses were performed by the Environmental Research Group (ERG) in Ann Arbor, Michigan and quality assurance control provided by Ms. Claudia Wiegand of SAIC's Trace Environmental Chemistry Laboratory located in La Jolla, California. More complete biosketches of the project team are presented in Appendix K. SAIC's programmatic and field staff from the Bellevue,

Washington office was led by Richard Greiling, P.E., project manager. Robert Peshkin, an SAIC geologist, supervised drilling operations, and collected and logged soil samples and drill cuttings. Patricia O'Flaherty and Glynda Steiner assisted in soil sampling, logging, well installation and development, and water sampling. Finally, Messrs. Greiling and Peshkin assisted by Ms. Steiner, performed the industrial outfall pipe exfiltration study.

2.0 ENVIRONMENTAL SETTING

2.1 PHYSICAL AND BIOLOGICAL ENVIRONMENT

George Air Force Base is located in Township 6 N. Range 5 W. on a gently sloping broad terrace in the western Mojave Desert of southern California. The base is approximately 20 miles northeast of the San Gabriel Mountains, and is adjacent to and above the right bank of the Mojave River, downstream of the Lower Narrows three miles northwest of Victorville. The Lower Narrows gets its name from the river cutting through outcropped rock and hills which prevented it from meandering across the floor of the valley.

The climate around George AFB is arid with long hot summers and short cool winters. Winter temperatures seldom drop below freezing while summer mean maximum temperatures are in the 90 to 100 degree Fahrenheit (°F) range. Mean annual temperature for the base is 62°F and mean annual precipitation is 4.2 inches according to data from DET 12, 25th Weather Squadron, George AFB. High rates of evaporation, however, cause the annual net precipitation to drop below minus 50 inches.

The plant communities on and near George AFB are typical of the dry climate of an upland desert environment. Creosote bush scrub is the predominant vegetational community in the undeveloped areas on base. Common plants in this community include creosote bush, Indian ricegrass, Mormon tea and Cheesebush. Typical plants of the joshua tree woodland community are also found on base and include the joshua tree, California juniper, boxthorn, and bladder sage. Wildlife in the vicinity of George AFB includes both desert and riparian species. Predominant desert species include black-tail jackrabbit, Audubon cottontail, and antelope ground squirrel (CH2M HILL, 1982). Federally listed threatened or endangered wildlife species have not been identified on George AFB, although the Mojave ground squirrel Citellus mohavensis and the desert tortoise Gopherus agassizi have been designated rare or sensitive, respectively, by state and federal resource management agencies.

2.2 GEOLOGY

George Air Force Base is located at an elevation of approximately 2,860 feet above sea level. This high desert region is part of the basin and range physiographic province, and it is completely surrounded by mountains. These boundaries include the San Gabriel and the San Bernardino mountains on the west and south, the Sierra Nevada Mountain Range on the north, and the Fry, Rodman, and Cady mountains on the east.

The Base lies on a relatively level alluviated plain which slopes gently to the north and east. Elevations of the plain range from 4,300 feet at the base of the southern mountains, to approximately 3,000 feet at Victorville, 2,860 feet at George Air Force Base, and 2,400 feet at Helendale at the northern edge of the plain.

Structurally, this part of the Mojave Desert is an alluvium filled valley. Geologic units of the region are characterized by either their water-bearing or non-water-bearing properties. Permeable rock formations which store and transmit significant quantities of water are known as aquifers. A variety of geologic formations can act as aquifers. The most widely developed aquifers consist of unconsolidated alluvial deposits, chiefly gravels and sands. These geologic features occur as water courses, buried valleys, plains, or intermontane valleys. The Mojave Basin is an intermontane valley. The water-bearing group is composed of unconsolidated to semiconsolidated alluvial deposits which are Quaternary in age, continental in origin and made up primarily of materials ranging in size from coarse sands and gravels to silts and clays. George Air Force Base is underlain entirely by these water-bearing sediments. The non-water-bearing formations are pre-Tertiary age crystalline rocks. These rock formations comprise the majority of the mountain and hill areas which enclose the Mojave Basin. These crystalline rocks also underlie the valley areas and are buried by the unconsolidated Quaternary alluvial deposits described above. During the field investigations SAIC scientists encountered only the uppermost water-bearing sedimentary units. These stratigraphic units appear to be areally extensive. Figure 3 is a generalized stratigraphic section of the unconsolidated deposits of the Mojave Basin in the vicinity of George AFB.

System	Series	Geologic Formation	Lithology	Max Thickness (feet)
QUATERNARY	RECENT	River Deposits	Qrd	90±
		Playa Deposits	Qp	25±
		Dune Sand	Qds	35±
		Younger Alluvium	Qal	100±
		Younger Fan Deposits	Qyf	75±
	PLEISTOCENE	Old Lake and Lakeshore Deposits	Qol	75±
		Older Alluvium	Qoa	1000±
		Older Fan Deposits	Qof	1000±
		Landslide Breccia	Qls	100±
		Shoemaker Gravel	Qs	300±
		Harold Formation	Qh	1300±

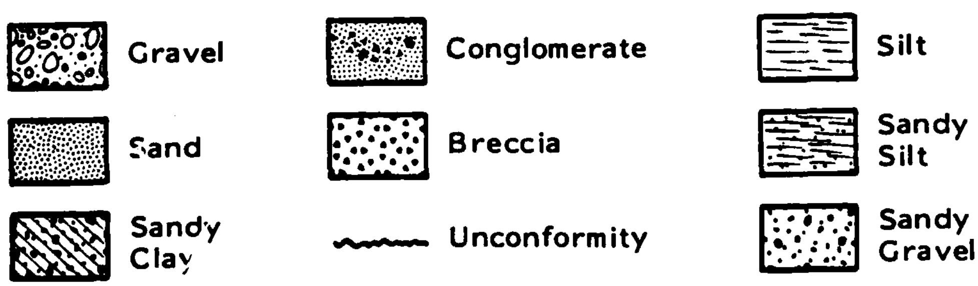


Figure 3

GENERALIZED STRATIGRAPHIC SECTION OF THE UNCONSOLIDATED DEPOSITS OF THE MOJAVE BASIN IN THE VICINITY OF GEORGE AIR FORCE BASE

(Note: Geologic descriptors [Qrd, Qp, Qds, etc.] identify age of stratigraphic unit [Q = Quarternary] and lithology [rd = river deposits, oa = older alluvium, etc.])

According to the State of California Department of Water Resources (1967), the water-bearing materials in the Mojave River basin include eleven lithologic units that range in age from Recent to Pleistocene (0-2.5 million years ago). They include fluvial deposits, lake and lakeshore deposits, playa deposits and dune sand, alluvium, fan deposits, landslide breccia, Shoemaker gravel, and the Harold Formation, which is a conglomeratic alluvial sand deposit.

The sources of these sediments are the pre-Tertiary crystalline complexes which make up the surrounding mountains. Streams carry debris into the basin during normal and flood runoff. Coarser materials settle out of suspension first. The fine-grained material is transported and deposited farther from the source rock. Groundwater moves through the spaces between rock or sediment particles and through fractures in solid rock. Rarely are these spaces larger than a fraction of an inch even in the coarsest material. George AFB is located near the northern limit of the alluvial terrace which begins at the base of the San Gabriel Mountains. The sediments which comprise the local aquifers are probably finer-grained than those closer to the sediment sources. As a consequence, the specific yield of the fine-grained materials are likely to be quite low.

2.3 HYDROLOGY

The Mojave River is the principle surface drainage in the entire Mojave hydrologic unit. This river flows to the north and east across the Upper Mojave Basin from its headwaters in the San Bernardino Mountains to its terminus approximately 80 miles from George AFB. Minor amounts of valley floor runoff contribute to the Mojave River and seasonally intermittent streams in the basin.

Groundwater supplies which are found in the nonindurated sediments of the Mojave Basin are from the same sources as the surface waters. Runoff from the San Gabriel and San Bernardino Mountains percolates through the unconsolidated alluvium and becomes groundwater. Groundwater movement within the Upper Mojave Basin occurs parallel and adjacent to the Mojave River in a generally south to north direction and the prevailing groundwater gradients generally conform to the regional slope of the land surface (California Department of Water Resources, 1967). Groundwater investigations for public and private

water supply wells on the upland desert near George AFB confirm that groundwater flow is in a north to northeast direction, which is consistent with the general slope of the land surface, and that the water table is most frequently encountered 120 to 160 feet below the ground surface (California Department of Corrections, 1983).

3.0 FIELD PROGRAM

3.1 PURPOSE

IRP Phase II, Stage 1 field work at George AFB included: (1) a magnetometer survey at the southeast base landfill site to determine the probable location of buried metallic wastes; (2) installation of ten groundwater monitoring wells to monitor water quality hydraulically upgradient and downgradient of past and present base waste disposal sites in the northeast, central, and southeast areas of the base; (3) collection of borehole soils and groundwater samples from each of the monitoring wells and groundwater sampling of an existing Air Force monitoring well; (4) collection of seven composite soil samples from the industrial outfall (Site S-20); (5) collection of two soil samples from the west perimeter roadway (Site S-4); (6) performance of an exfiltration test to locate perforated drain intervals along the industrial pipeline (Site S-20); and (7) a review of Air Force pressure test and other leak test data for the jet fuel pipeline and storage tank system. The locations of the study sites were identified in Figure 2. Groundwater and soil samples were analyzed for selected inorganic and organic compounds representative of wastes believed to be disposed of in base landfills or on base property. The following sections expand upon the purpose and approach of each of these Phase II objectives.

3.2 MAGNETOMETER SURVEY

The purpose of the magnetic survey was to locate sites within the closed southeast landfills that could contain buried 55-gallon drums believed to contain toxic substances. The IRP Phase I records search team reported that as many as 126 drums of liquid acetone wastes were believed buried in one or more landfill trenches. In addition to identifying potential burial locations, the magnetometer survey results were used to help locate the final placement of groundwater monitoring wells both hydraulically upgradient and downgradient of the confirmed landfill waste disposal areas.

3.2.1 Theory

The earth's magnetic field resembles the magnetic field of a large bar magnet or that due to a uniformly magnetized sphere. The origins of the field are

from sources originating from (1) inside the earth's core (94% contribution), (2) outside the earth, and (3) to a lesser extent from features on or near the earth's surface. The earth's magnetic field should be uniform, similar in effect to that of a bar magnet (dipole). Deviations of the magnetic field or the lines of magnetic flux are created regionally and locally by variations in the distribution of the amounts of magnetic materials on or near the surface of the earth. These variations or anomalies in the earth's field can be associated with naturally occurring materials, or buried iron objects and remnant cultural features associated with man's habitation. The cause of the anomaly can sometimes be inferred by measuring the intensity of the magnetic field over the anomaly and defining spatially the magnetic intensity fall-off and the lateral limits of the anomaly.

The proton precession magnetometer is the instrument most widely used to measure the earth's magnetic field. The proton precession magnetometer utilizes the precession of spinning protons (nuclei of hydrogen) which act as small, spinning magnetic dipoles. The hydrogen ions are temporarily polarized with a uniform field created by the magnetic field of a DC current through a coil of wire. When the temporary magnetic field is removed, the spin of the proton causes the axis of the rotating nucleus to precess about the direction of the earth's magnetic field. The spinning protons create a small AC signal in the surrounding coil of wire. The frequency of the signal is proportional to the total magnetic field intensity of the earth's magnetic field and independent of the orientation of the coil. The frequency is measured by digital counters and converted to the absolute value of the total magnetic field.

The measurement of the magnetic field intensity is expressed in gammas; one gamma is 1/100,000 of a gauss or 1/100,000 oersted. The earth's magnetic field varies from 60,000 gammas (0.6 gauss) in the polar regions to 30,000 gammas (0.3 gauss) in the equatorial regions. Located at 34° 35' North Latitude and 117° 21' West Longitude, it is anticipated that the earth's magnetic field near George AFB would measure 49,500 gammas.

The earth's magnetic field is subject to time variations created by solar-induced ionic distortions of the magnetosphere (the external field of the earth). These are generally (1) diurnal or daily variations (primarily during

daylight hours) as large as 100 gammas; and (2) micropulsations of variations of several tens of gammas. In addition to these variations are those created by magnetic storms as a result of changes in solar wind activity. These storms may last one day or up to several days and create disturbances of up to several hundred gammas in the magnetic field. The time duration of this type of magnetic disturbance may vary from minutes to days with both positive and negative fluctuations. This type of storm activity is generally predicted by the Space Environment Services Center operated by the National Oceanic and Atmospheric Administration.

Differential magnetometer readings between two points will largely remove the effect of time-related variations occurring in the magnetic field. Differential readings also filter out regional magnetic variations and enhance near-surface magnetic anomalies. When the differential readings are made in a constant manner, they are known as gradient measurements. Essentially, the resultant readings are made with a fixed distance between reading points such that the fixed distance is small with respect to the source of the anomaly. The difference in intensity divided by the distance between sensors is the gradient measured at the midpoint of the sensor spacing. Gradient readings may be in a vertical plane or in a horizontal plane.

3.2.2 Equipment

Gradient Magnetometer

An EDA Instruments PPM-500 Vertical Gradiometer was utilized to make the field measurements. This instrument is a microprocessor-based vertical gradiometer and registers the two proton precession sensors simultaneously to calculate and store in memory the vertical gradient, total field measurement of the upper sensor, time of reading and the field coordinates of the reading. The gradient measurement is at a vertical 0.5-meter spacing and is normalized to readings in gammas per meter. Processing sensitivity of the sensor readings is plus or minus 0.02 gammas with a display resolution of 0.1 gamma. The gradient tolerance of the instrument is 5,000 gammas per meter.

Base Station Magnetometer

A geometrics Model 856 microprocessor-based proton magnetometer was used as a base station to detect unusual magnetic storm activity during the field survey. Resolution of the Model 856 Proton Magnetometer is 0.1 gamma.

Field Computer Support

A HP-85 microprocessor computer was used to record and list the field data collected by both the above instruments.

Office Computer Support

An Apple II Plus microcomputer with a Houston Instruments DP-1 X-Y plotter was used to compile the field data and plot the results. The data were transferred between computers with an RS-232 modem.

3.2.3 Methods

Grid Layout

Figure 4 is a schematic of the southeast landfills upon which the magnetometer study was performed. Contained thereon are the grid coordinates and the baseline axes used as reference location points when establishing a 10-foot square grid within the general boundaries of the closed landfills. All points of the grid were referenced to these baselines. The survey area encompasses all of sites L-1 and L-3 as presented in the IRP Phase I report and as confirmed by the George AFB engineering department. Site L-2 is contained within the boundaries of L-1. The size and boundaries of the study area extend beyond any identified ground surface disturbances to landform or desert vegetation so as to ensure inclusion of all known or suspected landfill placements.

Once the outer boundaries were defined, the entire survey area was broken into nine separate sub-areas to facilitate ease in walking of traverses, data processing, and interpretation. The size and shape of the sub-areas were dictated by geometric shape and topography and not by any knowledge pertaining to the placement of fill or waste materials. The only surface depressions indicative of past disposal trenches were noted in Sub-areas A, D, E, and G.

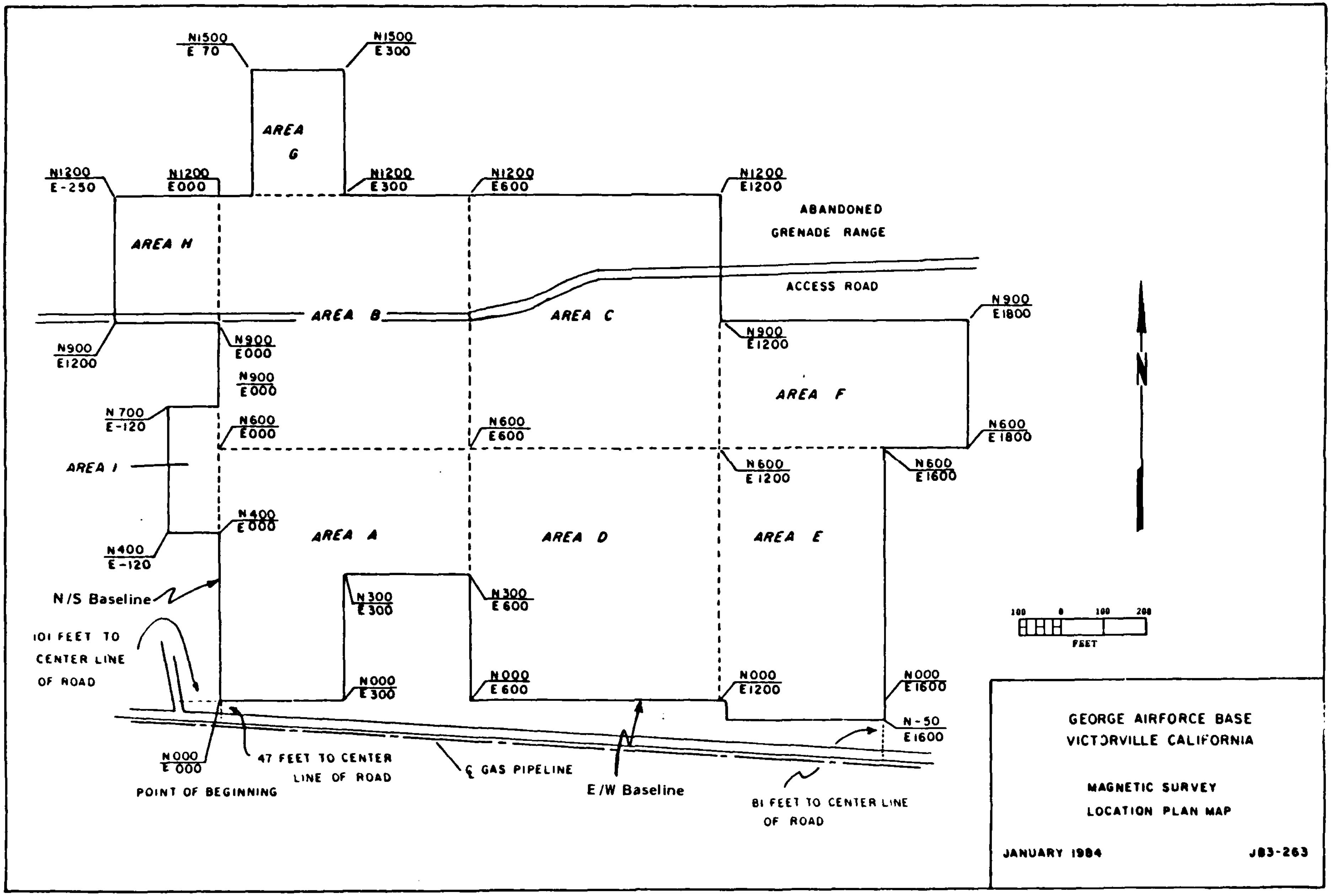


Figure 4

LANDFILL MAGNETIC SURVEY LOCATION PLAN MAP

The location of the east/west baseline was tied to the centerline of the gravel road lying north of the gas pipeline along the Township line between Townships 5 and 6 North. The Point of Beginning, N 000 and E 000, is located 46 feet north of the road centerline. It is also 107 feet east of the north/south trending road near the southwest corner of the landfill. The north/south baseline was constructed perpendicular to the east/west baseline and originates at the Point of Beginning.

Separate 600-foot chains, marked at 10-foot intervals, were laid out along each baseline. A third 600-foot chain was laid parallel to the east/west baseline. These chains served to orient the magnetic traverse lines which were run in a north/south direction. Double range poles were placed at each 10-foot station on both the north and south east/west chains to provide sighting markers to keep the north/south traverse aligned. Similarly, range poles were placed at appropriate distances (for example, 100 feet from the base line) on the north/south chain to verify position along the north/south traverse. As the traverses progressed eastward, the chains and poles were moved as required to maintain proper orientation of the traverses. All distances represent slope measurements. The relief of the terrain (0 to 20 feet) is such that minimal error is expected. As much as possible, all chain measurements were level chained.

Magnetic Traverse

The magnetic field measurements were made along the north/south grid lines at intervals of 10 feet. The PPM-500 recorded the measurements of (1) the total field at the top sensor, (2) the gradient measured at a spacing of 0.5 meters and normalized to a unit measure, (3) the coordinates of the grid point along the traverse updated automatically, and (4) the time of reading. The time interval between successive readings was typically between 10 and 15 seconds. Measurement along the traverse was "paced" and the position verified visually when crossing in line with the range poles placed on the north/south chain. The positional accuracy is estimated to be within two feet of the recorded point.

Heading errors for a change in the direction of the traverse, i.e., from a north/south direction to a south/north direction, respectively, were 1.5 gamma

increase in the Total Field and a 0.9 decrease in the Magnetic Gradient. The heading error is created by a change in position of the operator's body from one side of the magnetometer to the opposite side. For both traverse directions the instrument orientation remained constant. All magnetically susceptible objects were removed from the operator's person. The PPM-500 is constructed from non-magnetic materials, including the unit's battery.

As the PPM-500 is a microprocessor unit, all of the recording was accomplished automatically by the operator pressing one button, including the updated position along the traverse line. In this manner recording error was eliminated, and the operator could pay attention to his position along the line as he progressed. Errors that did occur in position, for one reason or another, could be easily identified and that part of the grid rerun. The memory storage capacity in the PPM-500 is 1,140 data points. When the memory bank of the unit was filled, the PPM-500 was "dumped" to tape storage using the HP-85. All of the day's data listed on paper tape were reviewed for completeness and errors that may have inadvertently occurred during the field day.

Base Station Control

The Geomagnetic Forecast Center of the Space Environmental Services Center at Boulder, Colorado was contacted and reported that the geomagnetic field activity for the dates of the field survey was "Active" with a Boulder "K" index of from 4 to 5. For this reason it was decided to include a Base Station recording magnetometer to monitor the magnetic field activity for possible geomagnetic storms. The base station was located at grid point N 800, E 000 and operated at a timed reading interval of 15 seconds during the working day.

At the end of each day's field work, the base station magnetometer data bank was "dumped" with the HP-85 computer. The data were then inspected to determine if the geomagnetic field was affected by unusual magnetic activity; i.e., whether or not there was an onset of a geomagnetic storm that would have affected the gradient readings taken during the day's field work.

3.3 DRILLING AND SOIL SAMPLING

Drilling of the monitoring wells installed at George AFB was performed using both hollow-stem auger and mud rotary drilling techniques. The hollow-stem

auger drilling was performed using a truck-mounted, Mobile B-53 drill rig owned and operated by Stang Hydronics of Orange, California. Eight borings were made using a 3-3/8 inch inside diameter hollow-stem auger. Pioneer Drilling of Redlands, California drilled two borings using mud rotary drilling techniques with a truck-mounted, Mobile R-80 drill rig. Mud rotary drilling had to be employed downgradient of the northeast disposal site after six unsuccessful boring attempts were made with the hollow-stem auger. Each of the six drilling attempts encountered a dense geologic material at 30 to 60 feet below the ground surface which could not be drilled with the auger technique.

Each well boring was generally made to 20 or more feet below the surface of the groundwater. It was suggested in the Phase I report that the static groundwater level beneath the base is about 110 feet below the ground surface based upon measurements of the groundwater surface in an existing Air Force monitoring well (MW-1) located near the north end of Runway 21. SAIC's investigation determined that groundwater surface levels were in fact generally deeper than 110 feet, ranging from 93 feet to 166 feet below ground surface. Groundwater surface measurements in the USAF monitoring Well MW-1 made during this study found the water table to be about 140 feet below the ground surface. Table 3 is a summary of the monitoring wells and boreholes which were installed at George AFB during this Phase II, Stage I (Confirmation) Investigation. This table outlines total depth, casing construction, sample zones and depths to groundwater at the time of drilling.

All drilling activities and techniques were overseen by an experienced SAIC staff geologist. The geologist maintained a detailed log of all materials encountered during the course of the work. Undisturbed sediment and soil samples were recovered at ten-foot depth intervals in the boreholes which were drilled with the hollow-stem auger. All samples were obtained using a standard split spoon sampler. A Standard Penetration Test was performed at the time of sampling. This test consists of driving a standard split spoon sampler into the soil a distance of 18 inches using a 140 pound hammer dropped 30 inches. The number of blows required to drive the sampler the last 12 inches is known as the Standard Penetration Resistance or N-value. The N-values provide a relative measure of compactness of granular soils such as sand, and the degree of softness or stiffness of cohesive soils, such as clays or silts.

Table 3

SUMMARY OF IRP PHASE II MONITORING WELLS AND BOREHOLES AT GEORGE AIR FORCE BASE

Well/ Boring ID	Depth (ft)	Casing Depth (ft)	Soil Sample Depth (ft)	Depth to Groundwater During Drilling (ft from ground surface)	Date Drilled
NZ01	132	0-112 blank 112-132 screen	Note "a"	105'	1/5-1/7/84
NZ02 (#1)	57	Abandoned	Note "a"	NA[b]	1/30-1/31/84
NZ02 (#2)	55	Abandoned	Note "a"	NA[b]	1/31/84
NZ02 (#3)	150	0-130 blank 130-150 screen	NA[c]	NA[d]	6/12/84
NZ03 (#1)	40	Abandoned	Note "a"	NA[b]	1/10/84
NZ03 (#2)	30	Abandoned	Note "a"	NA[b]	1/10/84
NZ03 (#3)	30	Abandoned	Note "a"	NA[b]	1/10/84
NZ03 (#4)	25	Abandoned	Note "a"	NA[b]	1/10/84
NZ03 (#5)	150	0-130 blank 130-150 screen	NA[c]	NA[d]	6/13/84
NZ04	137	0-117 blank 117-137 screen	Note "a"	117'	1/9/84
NZ05	140	0-120 blank 120-140 screen	085.5-086.5 115.2-116.2 135.3-136.3	121'	1/31/84
CZ01	163	0-143 blank 143-163 screen	050.5-051.5 070.5-071.5 140.5-141.5	135'	1/11-1/12/84
SZ01 (#1)	65	Abandoned	Note "a"	NA[b]	1/31/84
SZ01 (#2)	185	0-165 blank 165-185 screen	Note "a"	166'	1/31-2/3/84
SZ02	115	0-95 blank 95-115 screen	055-056 075-076 095-096	90'	2/4/84
SZ03	150	0-130 blank 130-150 screen	Note "a"	126'	2/5/84
SZ04 (#1)	160	Abandoned	Note "a"	139'	2/6-2/12/84
SZ04 (#2)	160	0-140 blank 140-160 screen	Note "a"	137'	4/9-4/11/84

Notes:

[a]Soil samples collected every 10 feet. Reported depths are for those samples selected for lab analysis with OVA sniffer.

[b]Groundwater not encountered prior to abandonment of drilling effort.

[c]Unable to select discrete soil samples during rotary drilling operations.

[d]Unable to measure depth to groundwater during drilling because of fluid drilling technique.

The soil obtained in the split spoon sampler was described and logged by the geologist. Two representative portions of each sample were saved in separate airtight glass jars for future chemical analysis. All samples were transferred from the split spoon sampler to 16 ounce wide mouth glass jars with Teflon® spatulas. The jars were sealed with a Teflon® inner cap liner. All samples were labelled with a code containing the date and time, well identification, sample depth and the name of the person collecting the samples. Any soil material remaining in the split spoon sampler was saved for more detailed visual geologic analysis. Each split spoon sampler was throughly cleaned in a mild soap solution ("Alconox"), rinsed with reagent grade methanol, and allowed to dry before re-use.

Soil samples to be chemically characterized were taken from monitoring Well Boreholes CZ01, SZ02 and NZ05. It was believed these boreholes had the highest probability for soils contamination based on the Phase I findings and because of their proximity to waste disposal sites. The soil samples scheduled for analysis were selected using a portable volatile organics analyzer (OVA) to measure volatile gases released from one sample of each soil sample pair collected during borehole drilling. The Foxboro Model 128 OVA meter was calibrated with a methane gas standard and all testing was done in a laboratory. OVA meter sensitivity was estimated to be approximately one part per million. No strip chart recorder was used and no OVA indicator dial readings were recorded. The OVA meter indicated the presence of organic contaminants in two of the soil samples. The OVA readings could not be replicated, however, when these samples were screened a second time. However, these two samples and four additional soil samples which appeared to have a high clay content and unusual discoloration were selected for chemical analysis.

The six borehole soil samples taken from Borings SZ02 and NZ05 were analyzed for oil and grease, phenols, chromium, lead, silver, chlorinated pesticides, volatile and aromatic halocarbons and moisture content. The three soil samples from boring CZ01 were analyzed for oil and grease and PCB concentrations. Samples were not obtained for either soil characterization or chemical analysis during mud rotary drilling because of the difficulty in securing undisturbed, clean soil materials.

Soil samples were collected in the industrial outfall ditch (Site S-20) located in the northeast portion of the base. This ditch provides drainage for stormwater collected from the flightline area, vehicle wash racks, street runoff, and precipitation falling on the operational apron. Runoff waters are carried by storm sewers on both the south and north sides of the apron. These storm sewers discharge to the open industrial outfall ditch. The storm drain in front of all hangers historically collected liquid industrial wastes in addition to precipitation runoff. The line was constructed with perforations to promote exfiltration in addition to surface discharge to the industrial outfall ditch.

Seven sample stations were identified in the outfall ditch. Two soil samples were collected from each station. Table 4 is a summary of all IRP Phase II shallow soil borings. Sample boreholes were drilled with the hollow-stem auger and soil samples were collected with a standard split spoon sampler at five and 10 feet below the ground surface. The two samples from each location were composited and then analyzed for oil and grease, phenols, heavy metals (chromium, lead and silver), chlorinated pesticides, volatile and purgeable halocarbons and moisture content.

Two soil samples were also collected from the roadbed of the west perimeter road. The soil samples were hand-dug, collected in sample jars, and then analyzed for oil and grease content. This site (Site S-4) was a disposal site for waste jet fuels between 1965 and 1966. It was reported that 1,000-gallon fuel bowsers were towed along the west perimeter road twice daily with their tanks discharging waste fuel onto the ground. There are no known documents to review which might help to determine if the waste fuel was distributed through an applicator to control dust, or merely disposed to waste the fuel.

3.4 WELL INSTALLATION

Monitoring wells were installed in each of the borings upon completion of borehole drilling and sampling. Each of the wells was constructed with two-inch I.D. Schedule 40 PVC which was inserted to the bottom of the boring through the hollow-stem auger. Threaded PVC pipe was used to avoid contaminating the wells with trace platicizer adhesive solvents. Two 10-foot lengths of threaded sections of slotted PVC pipe (slot size 0.010 inch) were screwed

Table 4

SUMMARY OF IRP PHASE II SHALLOW SOIL BORINGS AT GEORGE AIR FORCE BASE

Boring ID	Date	Depth (ft)	Sample Depth (ft)
PR01	2/02/84	0.5[a]	0.5
PR02	2/02/84	0.5[a]	0.5
PR02[b]	2/10/84	0.5[a]	0.5
ID01	2/03/84	10[c]	5.0/10.0[d]
ID02	2/04/84	10[c]	5.0/10.0[d]
ID03	2/03/84	10[c]	5.0/10.0[d]
ID04	2/03/84	10[c]	5.0/10.0[d]
ID05	2/03/84	10[c]	5.0/10.0[d]
ID06	2/03/84	10[c]	5.0/10.0[d]
ID07	2/03/84	10[c]	5.0/10.0[d]

[a] Surface soil sample from West Perimeter Road.

[b] Resampled surface soil from West Perimeter Road due to in-transit damage to original sample.

[c] Shallow borings to procure soil samples from open industrial outfall ditch.

[d] Composite sample of both depths.

together to form the well screen. A threaded end cap was attached to the bottom of the screen casing to prevent coarse-grained sediment materials from entering the bottom of the well. The remainder of the well casing above the screened portion was constructed of blank unslotted PVC pipe. The well screens were not sand-packed. Instead, unconsolidated sands and silts collapsed in and around the PVC pipe as the auger was removed. Approximately two to three feet of PVC pipe extends above the ground at each of the wells.

The drill string was removed from the borehole before the PVC well screen and casing was installed in the two boreholes drilled with rotary techniques and a bentonite mud slurry. Prior to removal of the drill string, however, fresh water was pumped down the string through the bit and up the annular space in an effort to flush bentonite from the borehole. The drill string was removed and the PVC pipe installed in the open borehole once the very fine clays were flushed from the boring. Clean, washed 16 grade silica sand was packed around the PVC casing and well screen.

To protect all installed wells from possible direct surface contamination, the annular space between the PVC well casing and the walls of the boring was sealed with bentonite in at least the top ten feet of the borings. Finally, a six-inch diameter protective steel casing with a locking cover was placed over the exposed PVC well pipe and cemented in place. A typical well installation is shown in Figure 5. Appendix D contains the monitoring well construction summaries.

Wellhead elevations and horizontal coordinates were provided by the U.S. Air Force and can be found in the well construction summaries. Vertical controls are presented as elevation in feet above mean sea level, while the horizontal controls are expressed as latitude, longitude and Lambert Coordinates. An explanation of the California Lambert Coordinate System is presented in Appendix H.

3.5 BOREHOLE LOGS

Logs of borings for the monitoring wells installed at George AFB are presented in Appendix D. Each log shows the various types of materials that were encountered in the borings and the depths and elevations where the materials and/or

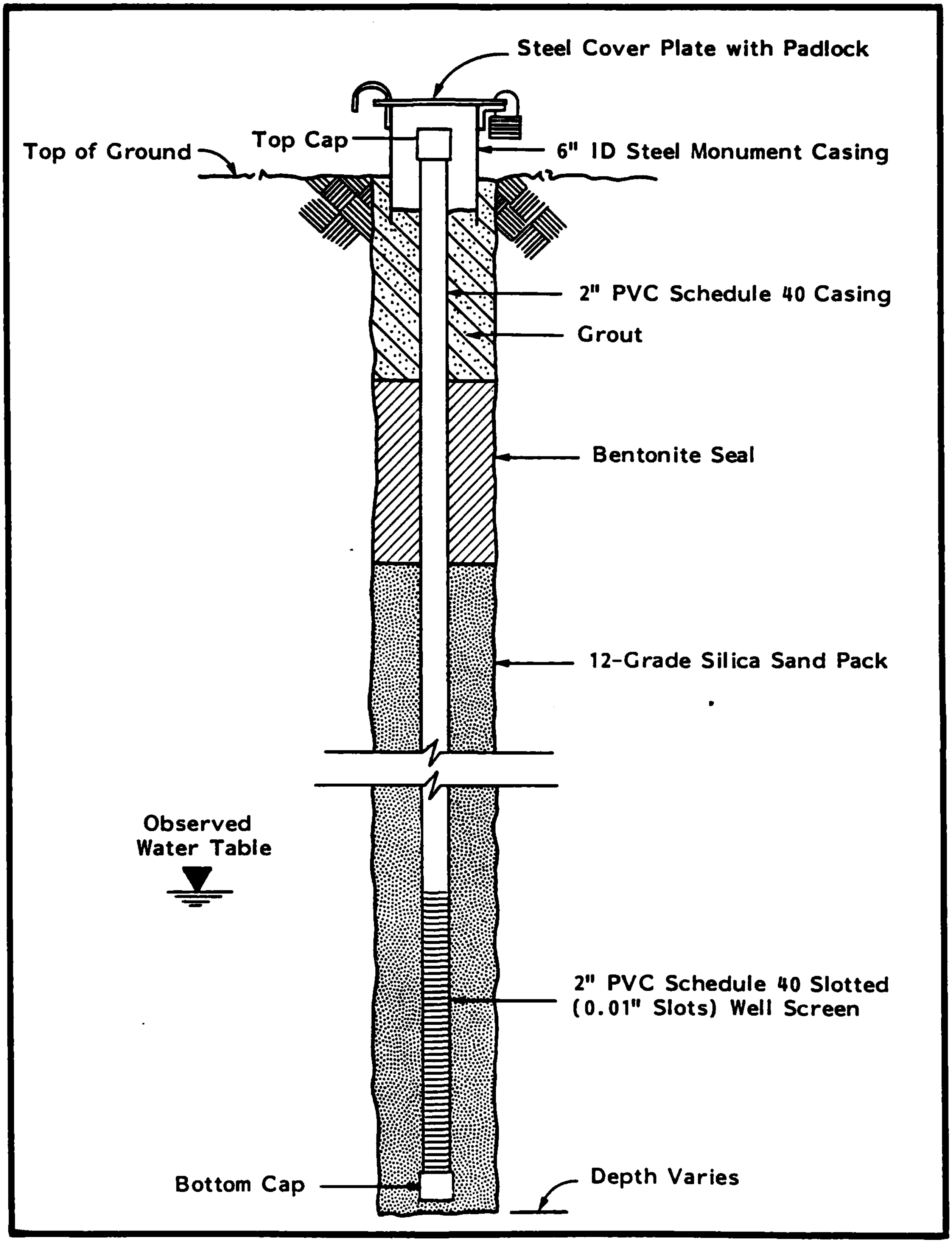


Figure 5

DETAIL OF TYPICAL MONITORING WELL

the characteristics of the materials changed. The well logs also record the number and depth of borehole samples taken during drilling, depth and location of well screen, measured groundwater level, the date on which the measurement was made, and the standard penetration resistance, or N-values, that were recorded during the split-spoon sampling. Table D-1 (Appendix D) defines the various modifiers used to describe soil classification and consistency on the boring logs. The graphic log for each boring conforms to the Standard Geologic Symbols for Unconsolidated Materials. These symbols are also presented in Appendix D as Figure D-1.

3.6 DEVELOPMENT OF MONITORING WELLS

Well development is the final step in completing a well. It is a technique whereby silts and other fine-grained sediments are removed from the aquifer in the vicinity of the well screen. This removal of the fine sediments settles the zone disturbed during drilling and restores the permeability of the geologic formation so that water can enter the well more freely. Well development techniques used on the monitoring wells at George AFB included a jet pump and hand bailing.

The jet pump is usually used as a water well production apparatus rather than a development tool. SAIC scientists attempted to use the jet pump as a well development tool because water and fine sediments are drawn from the formation and out of the well, as opposed to the surging action associated with an air lift pump or the turbulence associated with hand bailing. Several factors made the jet pump difficult to use, however. First, this equipment is intended to be used in a moderate to high-yield aquifer; however, the shallow water bearing zone beneath George AFB is composed of fine-grained, low permeability materials which yield only small quantities of water. Second, water required to prime the system at the remote well sites was difficult to secure and transport. Finally, the electric pump needs a gas or diesel 220-volt generator as an external power supply. The jet pump proved to be an ineffective well development tool after unsuccessfully using the equipment in three wells.

Instead, hand bailing was used as the primary well development technique on the monitoring wells at George AFB. As the simplest yet most tedious of development and flushing methods, hand bailing consists of repeatedly lowering,

filling, raising and dumping a small diameter well bucket. This well bucket is a Teflon® bailer similar to, yet simpler than, the point-source sampling bailer described in Section 3.7. This development and flushing bailer is constructed of Teflon® components with a stainless steel wire bail. It is 29 inches long with an outside diameter of 1.75 inches. The volume of this bailer is approximately 0.2 gallons. Unlike the point-source bailer which has both an upper and a lower ball check valve, this bailer only has a lower check valve. The bailer was lowered into the well on a nylon line and the used line was discarded after each well was flushed to avoid cross-contamination of wells.

Typically, wells are flushed until the discharge water is relatively clear and free of sediment. Because the aquifer underlying George AFB is composed of mostly fine-grained materials, however, most wells did not clear and were considered developed once an estimated 5 well volumes of water were discharged. Wells which fail to clear, however, will continue to pass fine-grained sediments through the well screen whenever water samples are taken. These sediments could cause false high heavy metal or synthetic organic contaminant concentrations because of the affinity for heavy metal cations and some synthetic organics to adsorb to clay and similar fine particles. Over time, the fine silts will also settle in the bottom of the well casing and may interfere with future well flushing or sampling, and may begin to reduce well yields.

A number of wells were almost dewatered during the period of bailing. The wells which yielded the lowest rates of water included SZ01 and SZ02 in the southeast corner of the base. In these instances, the wells were allowed to recover before returning later that same day or the next to continue bailing. Wells which exhibited the greatest recharge included NZ02, NZ03, and SZ03. These wells are located in the shallow canyons hydraulically downgradient of the northeast and southeast landfills, respectively.

3.7 SAMPLE COLLECTION AND PREPARATION

Groundwater samples were collected from the monitoring wells within 24 hours after the wells were flushed to insure that well stagnation would not bias the analytical results. Water samples for pollutant analyses were collected using a bailer constructed entirely of Teflon® components. Figure 6 illustrates the

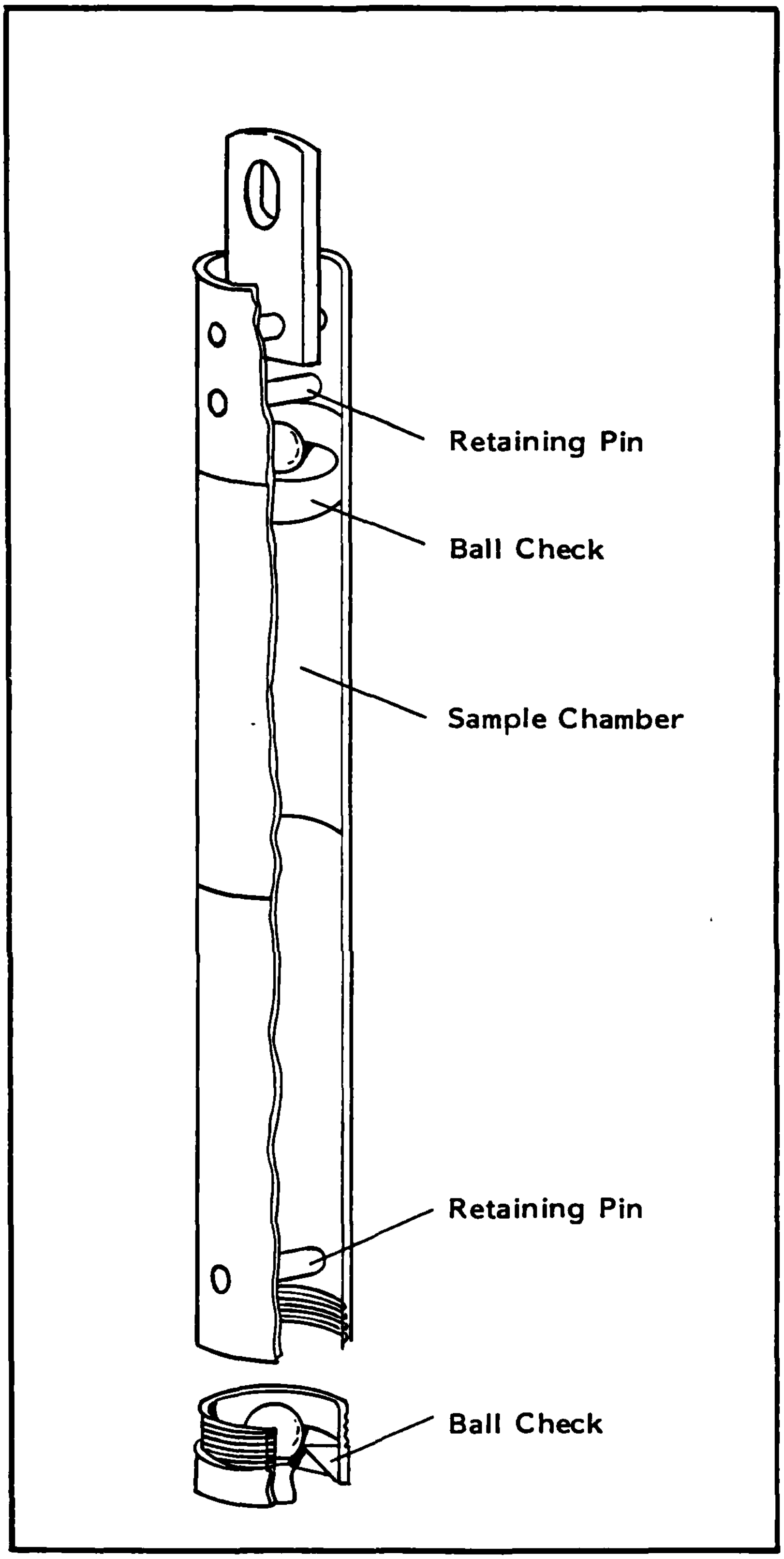


Figure 6

POINT SOURCE BAILER

point-source bailer which is 36 inches in length with an outside diameter of 1.66 inches. The volume of the bailer is approximately 0.2 gallons. A Teflon® ball built into both the top and the base served as upper and lower check valves which ensure the integrity of a water sample from a discrete zone. The bailer was lowered into the well on a nylon monofilament line. The used length of line was discarded after each well was sampled to avoid possible transfer of contaminants to other wells. The bailer was washed with a mild detergent solution ("Alconox") and rinsed with methanol prior to sampling another well.

Sampling proceeded from the top of the water column to the total depth of the well to minimize the effect of turbulence within the well casing. The sampling team would determine in the field the preferred depth position of the bailer and the frequency of samples pulled from the well. This was done to insure that sufficient volumes of water were collected throughout the water column to fill all sample bottles.

During sampling all wells were checked for temperature, conductivity, and pH. Temperature was recorded _in situ_ with an Omega Model 450 digital temperature indicator and thermistor. Water temperature measurements were made at 20 feet above the bottom and at the bottom of the wells. Conductivity and pH measurements were made at the wellhead as well water was being retrieved for chemical analysis. Conductivity measurements were made with a Chemtrix Model 700 conductivity meter which has a range of 0-20,000 micromhos/cm. This meter is equipped with a Chemtrix self-contained dip style probe with tungsten electrodes. Failure in the field to obtain an electrometric pH reading using a Chemtrix Model 400 pH meter, later attributed to a faulty shielded line coupling and large voltage drop, required that water pH be approximated using colorometric methods. As a result, pH measurements were made with Merck colorpHast® pH 0-14 indicator sticks.

Volatile organics were sampled in duplicate and placed in 40 ml bottles with Teflon®-lined septum caps. These bottles were always field checked to insure no air bubbles were entrained when the bottle was capped. Pesticide fractions were collected in one-gallon amber glass bottles. Oil and grease fractions were collected in duplicate 500 ml clear glass bottles and fixed with hydrochloric acid to increase the acid content to less than 2.0 pH units. Phenols

and total organic carbon fractions were each sampled in duplicate in 500 ml amber glass bottles. The phenol samples were fixed with one gram each of copper sulfate and phosphoric acid to reduce the pH to less than 4.0 units. Metals fractions were collected in one liter linear polyethylene bottles which were fixed with nitric acid to increase the acid content to less than 2.0 pH units. Polychlorinated biphenyl (PCB) fractions from Well CZ01 were collected in duplicate in one gallon amber glass bottles.

Once all the samples were collected, the bottles were sealed, labelled, wrapped in bubble packing material, placed in coolers and covered with crushed ice. At the end of the day, all samples were removed from the coolers, inventoried against the field log notes, and a sample chain-of-custody log (see Appendix I) was prepared. All samples were packed in shipping coolers, again covered with ice, and the coolers were sealed and secured. Breakaway and/or tear resistant tape was used to seal the coolers per chain-of-custody protocols. All tape seals were signed by the sampling team leader. The samples were then taken to the SAIC Trace Environmental Chemistry Laboratory in La Jolla, California by the field sampling team. Upon arrival at the lab, all samples were inventoried against the chain-of-custody log and the sample bottles inspected for sample integrity. Once a lab identification number had been assigned to each sample, the chain-of-custody log was signed and a copy was returned to SAIC-Bellevue for confirmation of receipt.

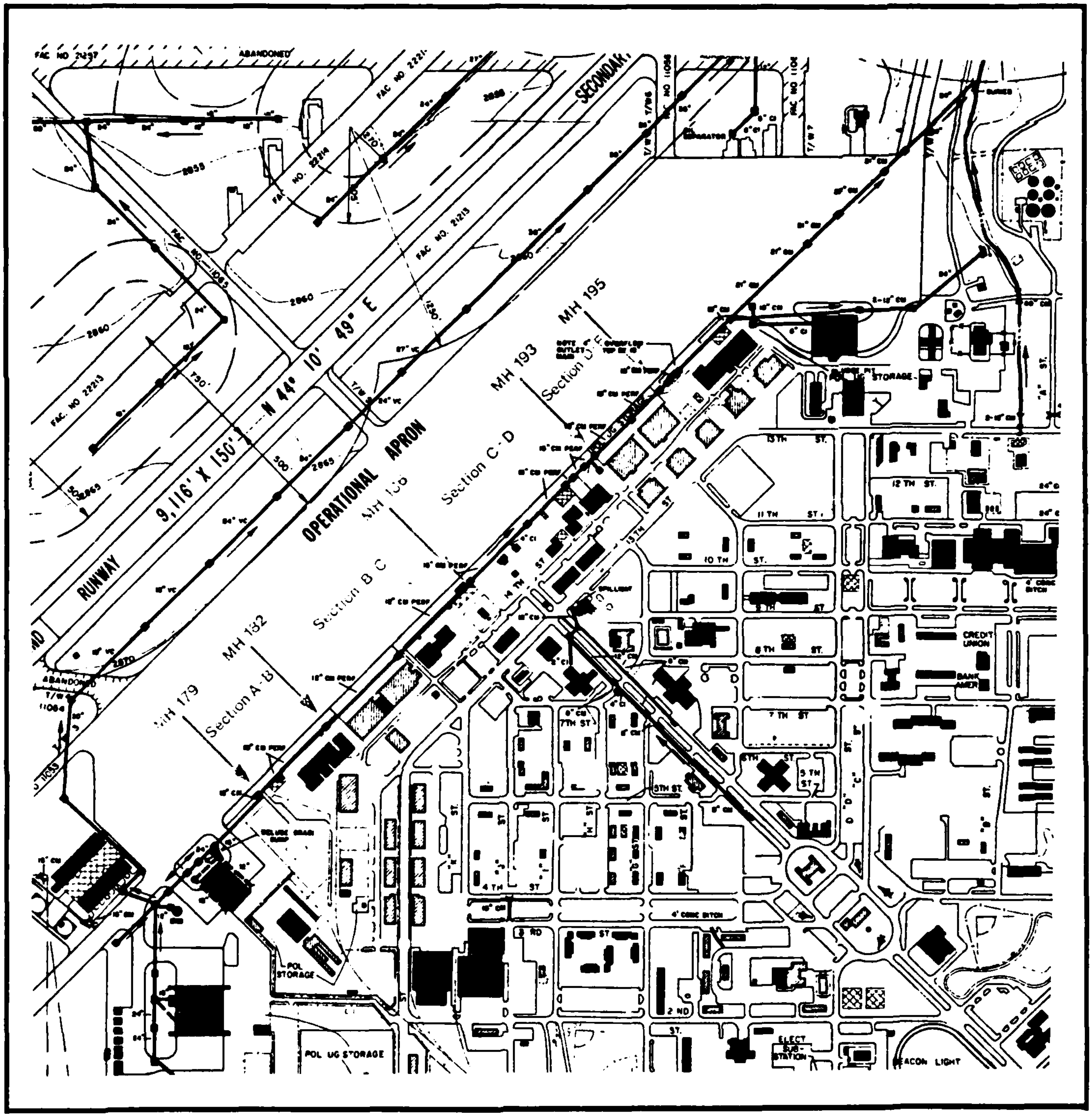
The SAIC laboratory sample backlog was high at the time of sediment and water sampling on George AFB. As a consequence, SAIC chemists requested and received permission from OEHL to award a subcontract to Environmental Research Group (ERG), of Ann Arbor, Michigan, to perform the required chemical and physical analyses. ERG is a contract analytical laboratory certified by the U.S. Environmental Protection Agency to perform all of the analytes of concern in this field investigation. Following OEHL approval, all samples were shipped to Ann Arbor, Michigan for chemical analyses. All samples arrived at Ann Arbor and underwent preparation within the maximum allowable holding times (e.g., 14 days for volatile organic chemicals). Two water samples, however, broke in transit during this second sample transfer.

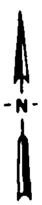
3.8 INDUSTRIAL PIPELINE EXFILTRATION TEST

An exfiltration test was performed on those segments of the storm sewer located along the southeast side of the operational apron which have previously received or continue to receive industrial waste discharges or washdown waters from industrial, mechanical or aircraft maintenance activities. The purpose of this test was to confirm the presence of perforated corrugated metal pipe as shown on base utility drawings (Tab G-3) and to determine the rate at which water escapes from those portions of the storm sewer. Air Force records indicate this flightline storm drain was designed with perforations so as to allow for absorption of water into pipe bedding and ground as well as discharge to the outfall ditch. However, when first constructed, it served also as an industrial wastewater line because of a number of interties with maintenance hanger floor drains and industrial process drains. As a consequence, industrial contaminants, in addition to flightline fuel spills and trace contaminants washed off by rainfall, would also percolate into the ground.

The Phase I report and follow-on conversations with base engineering staff confirm that floor drains from several maintenance hangars along the apron have been diverted from the combined storm sewer and industrial discharge line. All industrial wastes now discharge to the sanitary sewer and to the regional wastewater treatment plant serving the Victor Valley and George AFB. As a result of these efforts to eliminate sources of pollutants, it is now believed that the storm sewer presently receives only the runoff from the operational apron, wash water from several aircraft and truck wash racks along the apron, and the vehicle wash down water from the fire station.

Approximately 3,040 feet of the storm sewer was tested. Figure 7 identifies the location of those sections of the industrial/storm drain line tested which lie between manholes designated as Nos. 179 and 195. The storm drain between these manholes is comprised of 10, 12, 15 and 18-inch diameter corrugated metal pipe. Portions of the pipe are shown on base utility drawings to be perforated. It is assumed these perforations are evenly spaced around the circumference of the pipe and at equal but unknown intervals along the length of pipe. The storm sewer was plugged at five locations (designated as Manholes A through E) for the purpose of quantifying an exfiltration rate for





(No Scale)

Figure 7

INDUSTRIAL/STORM DRAIN SECTIONS TESTED FOR
EXFILTRATION AT GEORGE AIR FORCE BASE
(Source: George AFB Utility Drawing G-3)

each of the segments having a different pipe diameter size. Mechanical sewer plugs as manufactured by the SIDU Corporation in Long Beach, California were used to retain the water and maintain the hydrostatic pressure head in the line.

The exfiltration test was performed sequentially, starting in the upstream Section A-B and working downstream to Section D-E. The sewer plugs were seated in predetermined positions in selected manholes. To enable the measurement of the exfiltration rate in Section A-B, a 10-inch plug was installed immediately upstream of Manhole #179 and a 10-inch plug seated upstream of Manhole #182. This same procedure was followed to obtain the exfiltration rates in Sections B-C, C-D and D-E. Placement of the plugs for each of the above sections is as follows: a 12-inch plug was installed immediately upstream of Manhole #186, a 15-inch plug was installed immediately upstream of Manhole #193, and an 18-inch plug was installed immediately downstream of Manhole #195.

Fire hoses were used to fill the industrial lines and manholes with water. The distance from the manhole rim to the water surface was measured and recorded at each of five key manholes. Measurements were recorded approximately every five minutes during the first part of the test while the water levels were dropping rapidly. This rapid drop in water surface was due to the loss of that volume of water in the manhole yet above the crown of the pipe. Measurements were taken less frequently as the water level within a monitoring manhole declined more slowly once the water surface passed below the crown of the sewer and the displacement volume of water lost became large relative to small changes in measured distance to the water surface. The exfiltration test within a given line segment was stopped when either there was no change in depth to the water surface over two consecutive 15-minute periods, or if the line exfiltrated such a large volume of water that the water surface actually drained out of the manhole.

When the test was stopped, the drain line was opened in the downstream plug to allow any retained water to move downstream to the next plugged section. Once all of the water was released, the drain plug was resealed, and the lower section flooded and the test procedure renewed. The mechanical plug in the upgradient manhole in the sewer section having just been tested was then retrieved and cleaned.

4.0 DISCUSSION OF RESULTS AND SIGNIFICANCE OF FINDINGS

This section presents the results of all field survey activities and analytical and interpretative conclusions obtained when integrating chemical characterizations with field observations and findings. The results are presented by geographic area and site. A summary of conclusions at the end of this section provides a complete overview of basewide and site specific findings.

4.1 MAGNETOMETER SURVEY OF SOUTHEAST LANDFILLS

4.1.1 Data Development

The southeast landfill area was divided into Sections "A" through "I," based on a maximum 600 x 600 foot division (refer back to Figure 4). These divisions were lettered in the order that the survey progressed. This figure also shows the field reference location marks as coordinate grid points and other reference locations of various features within the area of exploration.

The raw magnetic gradient for each of the data points of the 10 x 10 foot grid were sorted into gradient ranges dependent upon values that would be representative of magnetic features found within the closed landfills. These gradient ranges are:

- Division I - Gradient values +10 to -10, representative of no disposal activity and minimal bulldozer scraping activity
- Division II - Gradient values -10 to -100, representative of trenching activity
- Division III - Gradient values less than -125, representative of filled trenches with nonmagnetic materials and with varying amounts of decomposition of the disposed items filling the trench
- Division IV - Gradient values +10 to +50, representative of some magnetic materials and compaction of the backfill
- Division V - Gradient values +50 to +100, representative of magnetic materials filling the trench
- Division VI - Gradient values +100 to +200
- Division VII - Gradient values +200 to +500
- Division VIII - Gradient values greater than +500

The divisions of the measured gradients are presented in Appendix E for each grid point. Figures E-2 through E-10 present a summary of all magnetometer gradient data with a bold line separating Division I data results from all other data. This line can be distinguished in the field as the edge of the undisturbed soil or vegetation.

The landfill site had a great amount of magnetic noise as background. This magnetic noise was largely created by scattered metallic debris lying on the surface. Such debris included discarded clothes washer and dryer machines, empty 55-gallon drums, one-quarter inch steel plates, metal sign posts and miscellaneous steel or iron construction material. A filter was applied to the data to eliminate the higher frequency background noise. The filtered data shown in Figures E-11 through E-19 represent a plot of those points whose gradients exceed +100 gammas per meter. Gradients greater than +100 represent potential target areas for burial sites of the drums. Bold lines on the figures were drawn to highlight continuities among high gamma readings or cluster patterns which probably indicate disposal trenches.

4.1.2 Summary of Magnetometer Survey Results

A summary location map of the above areas is shown in Figure 8. This map combines the filtered results presented in Appendix E and identifies the presence of buried metallic wastes and those potential burial site locations within the closed landfill site. The magnetometer data indicate that soil disturbances extended outside of the grid survey boundaries. Post survey field confirmation was performed to validate the data and define the boundary of the disturbed zone.

The magnetometer data allow the user to approximate the mass of the magnetic anomaly, but not the shape or other features of the material. Ground-penetrating radar employed in the areas of suspected landfill materials may help define the shape or form and depth to the buried materials. However, because of the similar shapes and cluster patterns, the results of this magnetometer survey were beneficial in locating three monitoring wells (SZ02, SZ03, and SZ04) hydraulically downgradient of the southeast landfill sites.

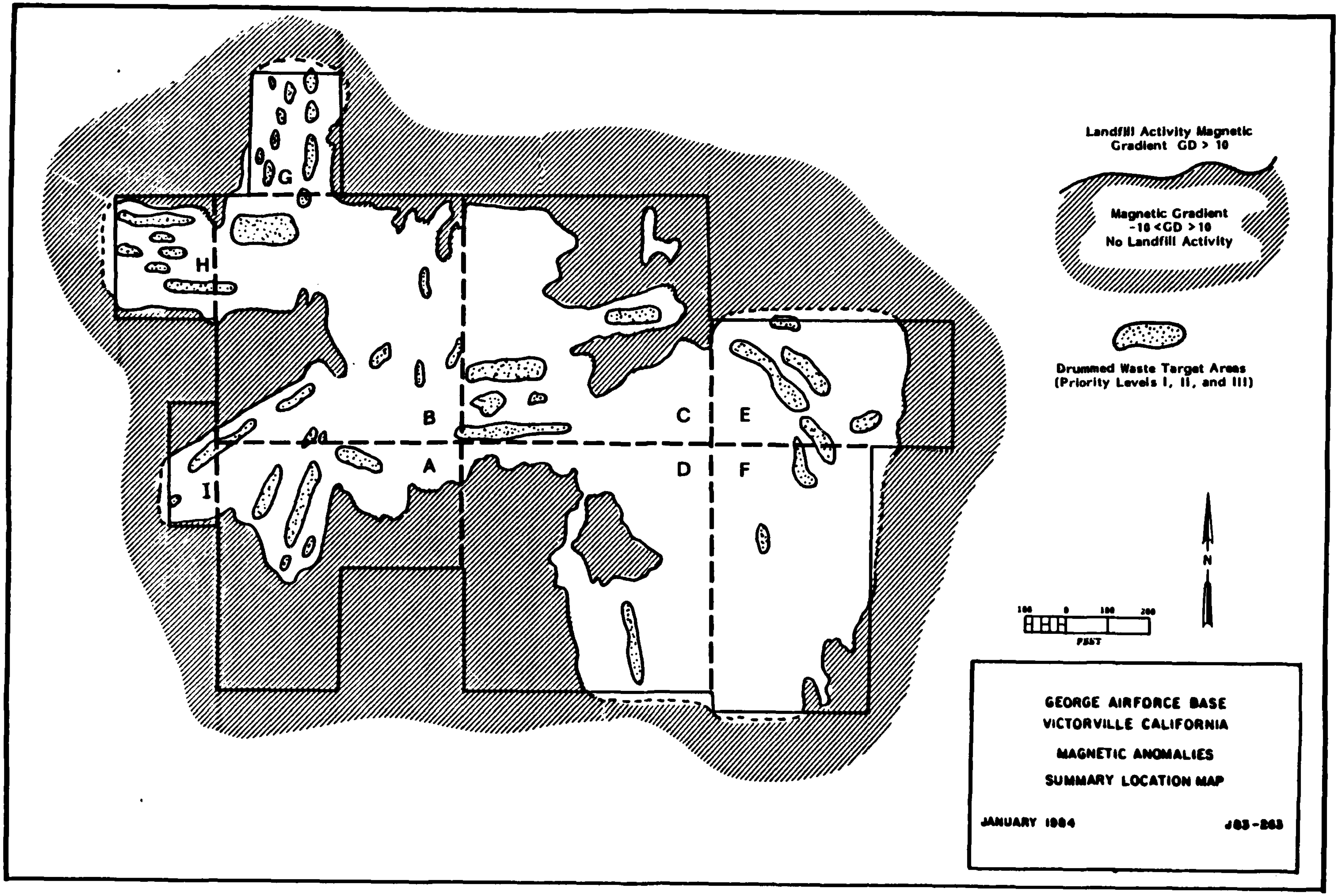


Figure 8

TARGET AREAS OF POTENTIAL BURIAL SITES CONTAINING 55-GALLON DRUMS
GEORGE AIR FORCE BASE

The magnetometer survey also confirmed the presence of landfill trenches suspected of being in Subareas A and G, but were not as definitive in confirming landfill trenches in either Subareas D or F. This anomaly may be possible if the excavated trenches in the latter areas were filled with putrescible wastes only, or were backfilled with native material.

The magnetometer survey confirms the presence of metallic (possibly drummed) wastes in the northwest corner of Subarea B (see Figure 8). This 200-foot by 100-foot area of high magnetic gradient may be associated with Site L-2 disposal of tank bottoms from leaded gasoline and JP-4 fuel storage tanks. The magnetometer survey also identified numerous disposal trenches in Subarea H which were designated in the Phase I report as Site L-3 and suspected of containing low-level radioactive wastes, or quite possibly Site M-2, a disposal site for small arms residue and oils. The long trench along the north boundary of Subarea H, however, approximates more closely the 200 x 15 foot trench described in the Phase I report as containing leaded tank bottoms and designated as Site L-2. A comparably long and narrow trench is also indicated in the southeast sector of Subarea H. Because the shape of these trenches more closely represent that described in the Phase I report which was used for disposal of leaded tank bottoms than does the shape of the larger area in Subarea B, and because signs warning of radioactive wastes are posted in the northwest corner of Subarea B and not Subarea H, it is suggested that sites designated L-2 and L-3 are reversed. This reversal is also suggested by the base master plan drawing G-3 which locates both the radioactive waste and the tetraethyllead disposal sites within the confines of the landfill proper (i.e., east of the north-south baseline) and at the western edge of the mouth of the small canyon to the north of the landfill (Subarea G) which is now documented to contain buried wastes.

The magnetometer survey identifies a small disposal area in the southwest corner of Subarea I (see Figure 8) which may be the site of buried jet engine starter cartridges designated in the Phase I report as Site L-4. Finally, approximately ten 250-foot long disposal trenches and approximately 25 burial sites or short trenches, all of which yielded high magnetic gradients, are located across the landfill site. One or more of these burial sites could contain the drummed liquid solvents reportedly buried in the southeast landfill.

4.2 HYDROGEOLOGIC INTERPRETATIONS

Ten monitoring wells constructed during this Phase II investigation supplement a single deep monitoring well constructed in 1977 when unlined infiltration ponds were used for wastewater effluent disposal. The locations of these wells and related shallow borings are shown on Figure 9. The borings made for this study also supplement existing knowledge of the local geology that indicates subsurface materials are generally fluvial, lacustrine, dune and playa deposits which comprise a fine-grained, low-yielding aquifer. These sediments are the erosional products of the surrounding mountains which were carried into this alluvium filled basin during normal and flood runoff.

George Air Force Base is underlain by a thick sequence of unconsolidated to semiconsolidated water-bearing alluvial sediments on top of non-water-bearing crystalline rocks. These units appear to be areally continuous as evidenced by the fact that the crystalline rocks enclose the Mojave Basin as mountain and hill areas which surround the basin, and the apparent areal continuity of the unconsolidated deposits as evidenced by the occurrence of a brown, dense clay unit in all of the deep borings. Figure 10 is a contour map of the top of the clay based on data obtained during drilling. These contours illustrate the attitude of the clay is generally concurrent with the slope of the land.

The elevations of the groundwater surface determined from water level measurements made in the field are summarized in Table 5. All wells except NZ02 and NZ03 had been at rest several weeks since drilling and water table elevations are stable. Rapidly declining water table elevations as measured in Wells NZ02 and NZ03 indicate that flushing water or drilling fluids are still influencing the formation. Drilled less than four days prior to monitoring, at least one week is the generally preferred recovery period prior to sounding for static water table elevations. A contour map of the groundwater surface based upon measured depths to the static water table is presented in Figure 11. It is noted from this illustration that the groundwater surface slopes northeast towards the Mojave River consistent with the slope of the land and the clay unit. Figure 12 illustrates the directions and magnitudes of the slope of the water table. There is both a northerly and easterly component with an approximate resultant flow towards the northeast and the Mojave River. The gradient in the northeast direction of flow as measured between Wells CZ01

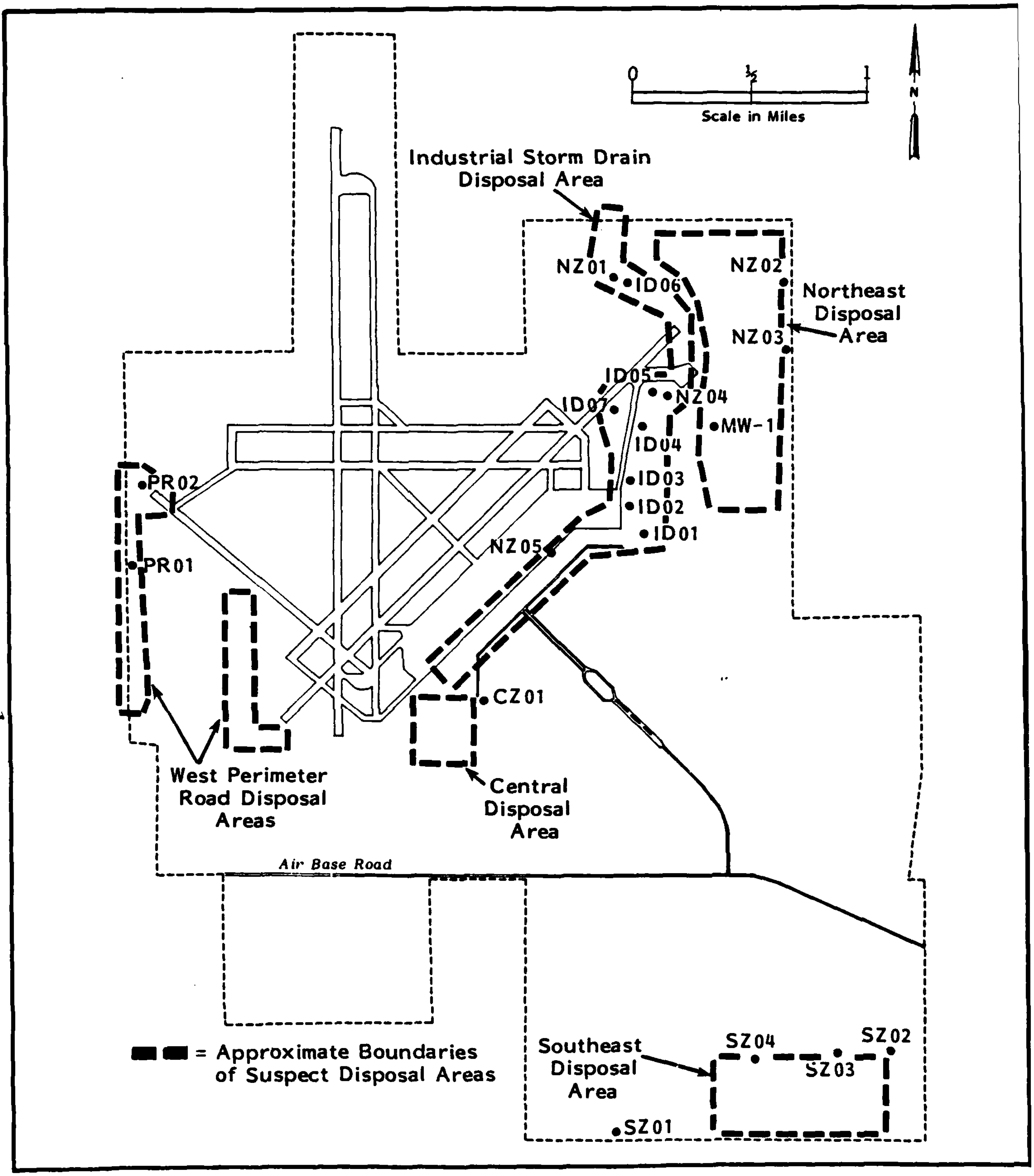


Figure 9

LOCATOR MAP FOR ALL IRP PHASE II MONITORING WELLS, SHALLOW SOIL BORINGS AND SURFACE SOIL SAMPLING SITES GEORGE AIR FORCE BASE

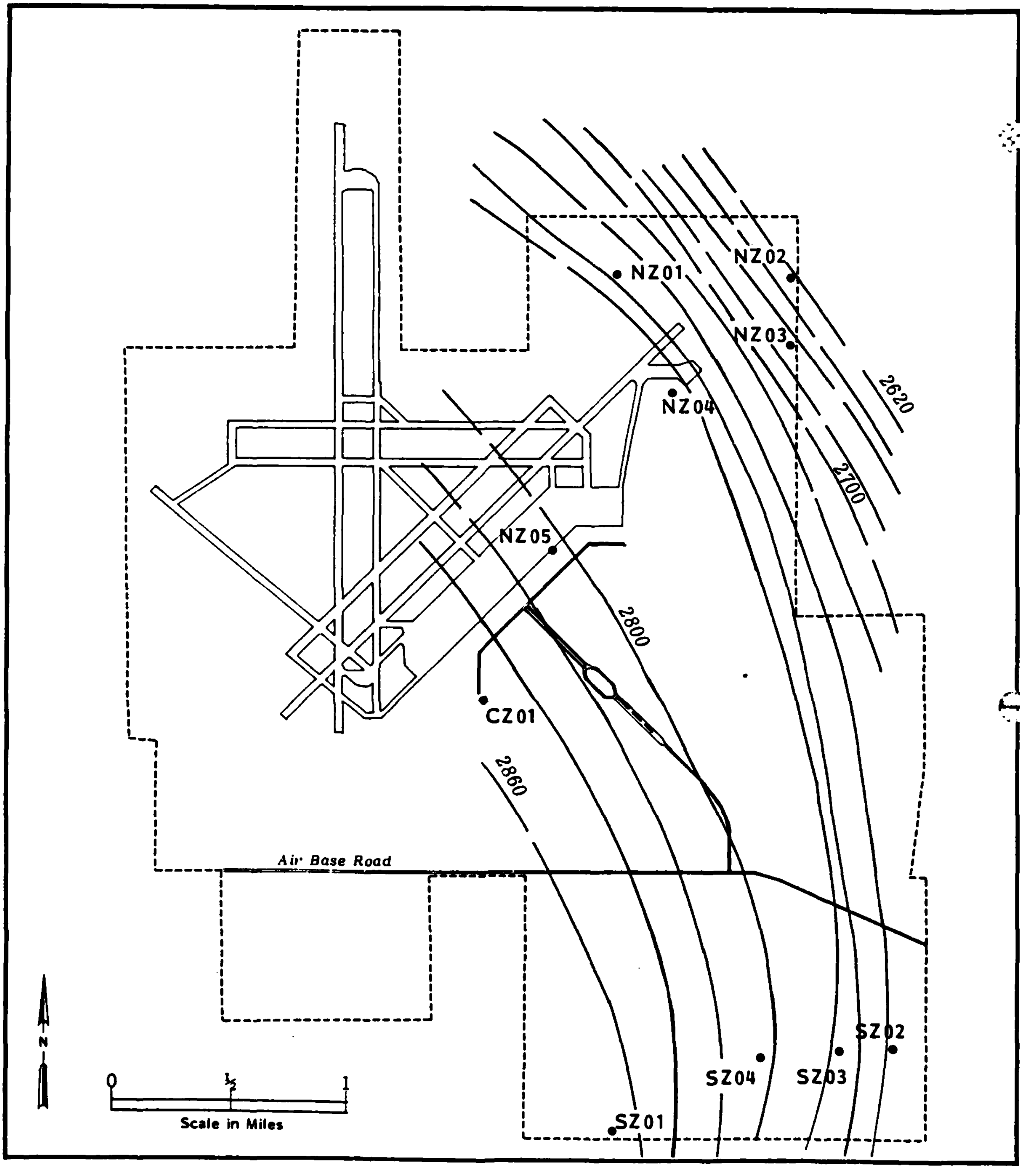


Figure 10

ELEVATION CONTOURS OF THE TOP OF STRATIGRAPHICALLY SIGNIFICANT CLAY UNIT BENEATH GEORGE AIR FORCE BASE
(Contour interval is 20 feet; elevations expressed as feet above MSL)

Table 5

SUMMARY OF WATER TABLE ELEVATIONS IN MONITORING WELLS AT GEORGE AIR FORCE BASE

Well ID	Water Table Measurement Data: During Drilling	02/11/84	04/10/84	06/14/84	06/16/84	$\overline{X}$
CZ01	2746.9[a]	2748.9	2746.9	2746.9		2747.4
NZ01	2709.6[b]	2721.6	2719.6	2718.6		2719.9[d]
NZ02	(c)			2598.5	2588.5	2593.5[e]
NZ03	(c)			2615.6	2590.6	2603.1[e]
NZ04	2727.2	2726.2	2724.2	2725.2		2725.7
NZ05	2743.4		2739.4	2739.4		2740.7
SZ01	2759.9	2764.9	2759.9	2759.9		2761.1
SZ02	2731.6	2733.6	2734.6	2735.6		2733.8
SZ03	2736.7[b]	2757.7	2754.7	2751.7		2754.7[d]
SZ04	2753.3			2755.3		2754.3

[a]Feet above mean sea level.

[b]Uncertain as to cause of depressed water table elevation during drilling.

[c]Due to use of drilling fluid, water table elevation immeasurable.

[d]Mean water table elevation excluding inexplicable depressed water table elevation during drilling.

[e]Tentative water table elevations due to short time period since wells were drilled. Rapidly declining water table indicates flushing water and/or drilling fluids may still be influencing formation.

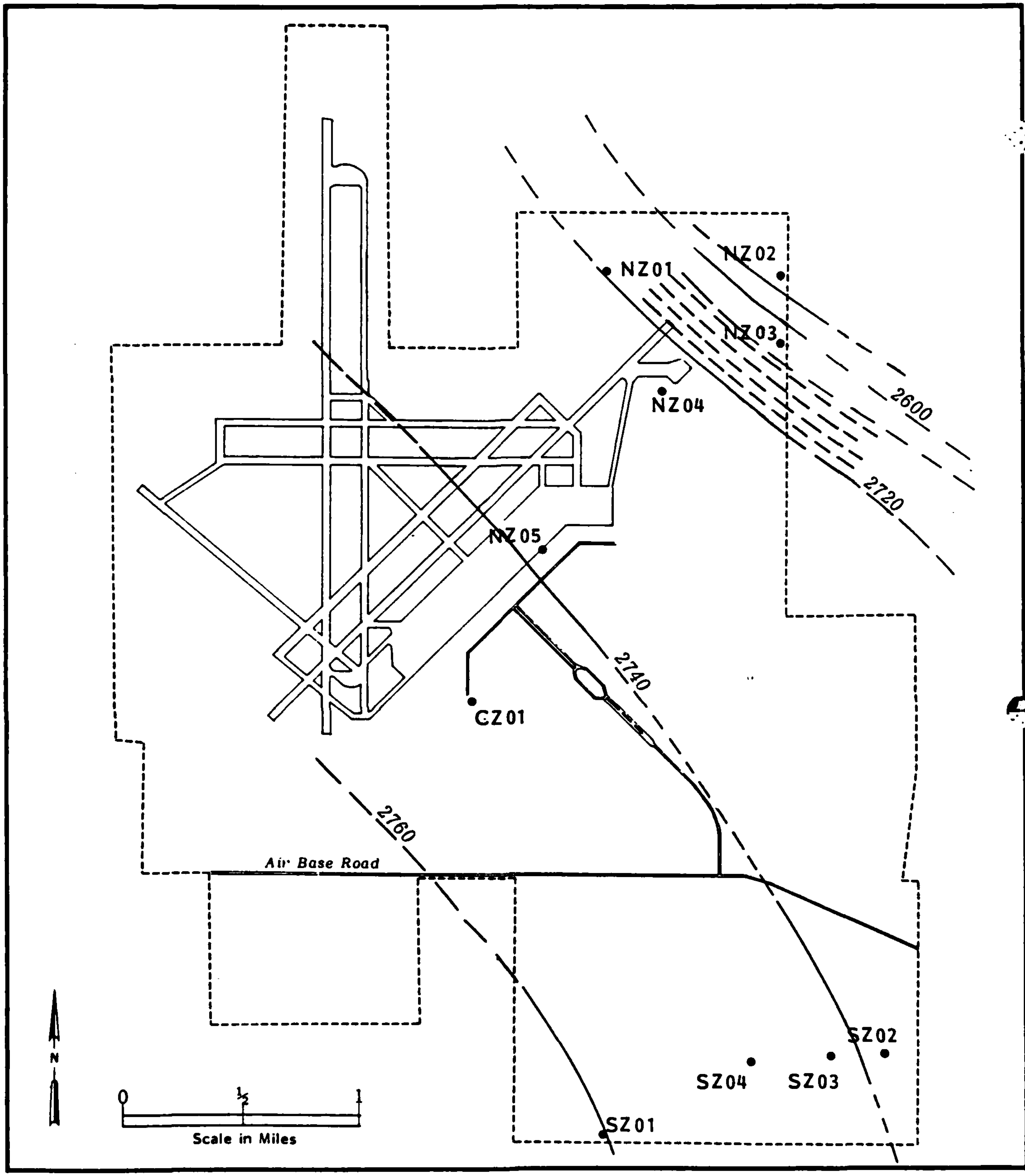


Figure 11

ELEVATION CONTOURS FOR GROUNDWATER TABLE BENEATH GEORGE AIR FORCE BASE
PERIOD OF MEASUREMENTS: 1984, APRIL-JUNE
(Contour interval is 20 feet; elevations expressed as feet above MSL)

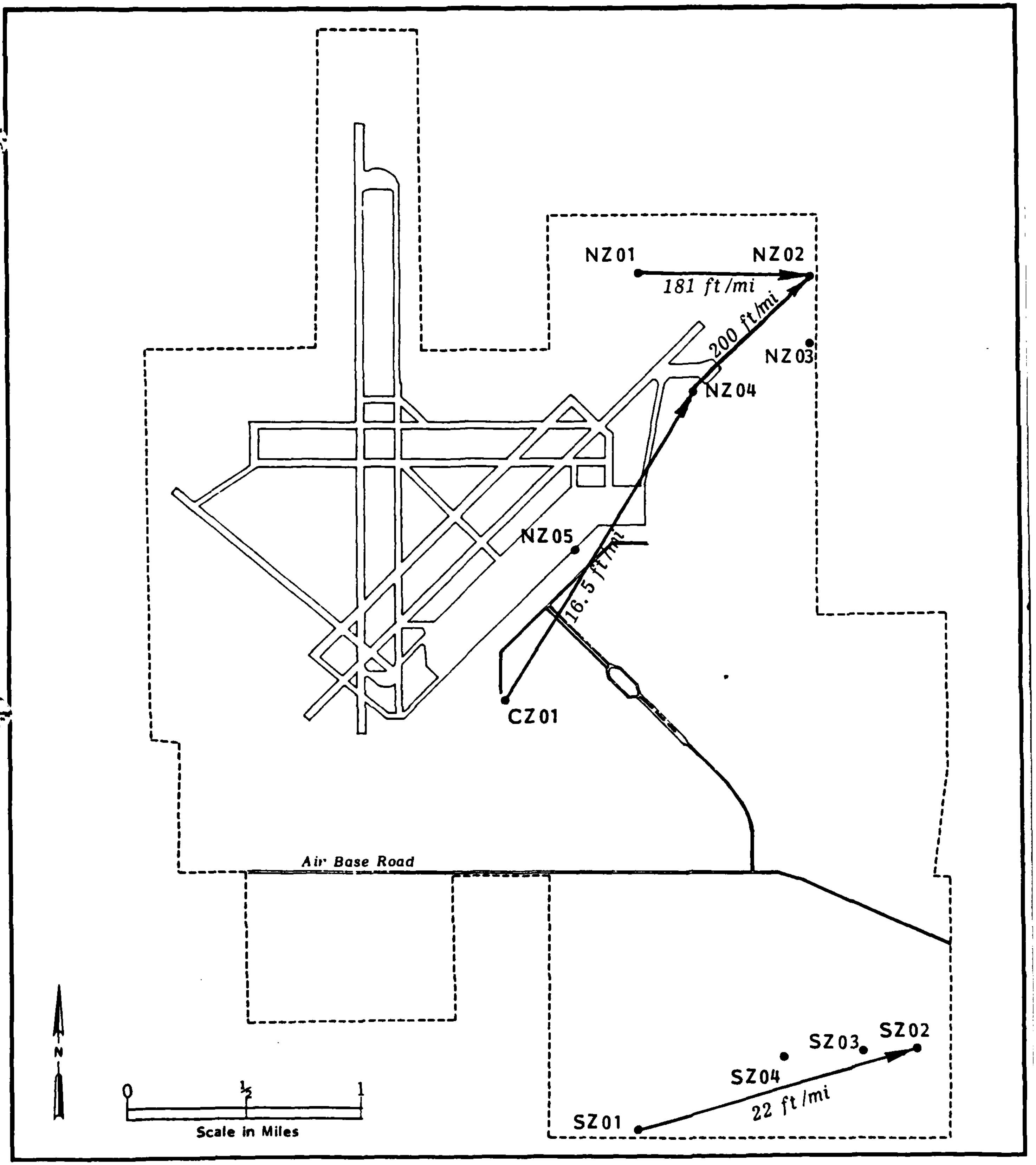


Figure 12

GROUNDWATER GRADIENTS FOR WATER TABLE BENEATH
GEORGE AIR FORCE BASE

and NZ04 is 16.5 feet per mile (ft/mile), while that between Wells NZ04 and NZ02 is 200 ft/mile. The first and lower value (16.5 ft/mile) would be more representative of the regional groundwater gradient beneath the upland plateau (see California Department of Corrections, 1983), and is more representative of the 31 ft/mile drop in ground surface elevation across the base in the same northeast direction. The low groundwater gradient is also comparable to the 22 ft/mile gradient measured across the southeast landfill. The steeper gradients in the far northeast corner of the base are a result of the large topographic relief as the valley wall drops towards the river. The measured verticle drop is approximately 240 feet at a gradient of 320 ft/mile. This relief was caused by the Mojave River cutting through the alluvial plain.

4.3 SOIL AND GROUNDWATER CHEMISTRY

Each monitoring well was sampled according to the procedures described in Section 3.7. All samples were delivered to the SAIC Trace Environmental Chemistry Laboratory by the field sampling team, and later shipped to the laboratories of the Environmental Research Group (ERG) in Ann Arbor, Michigan because of sample backlog in SAIC's laboratory. The methods employed in sample preparation and chain-of-custody are identified in Appendix I. All the data were reviewed and verified by both ERG and SAIC laboratory personnel, and the data were then forwarded as hard copy outputs to the SAIC-Bellevue office for tabulation and interpretation. Table 6 is a summary of the data from the chemical analysis of the soil samples. Included in this summary are the samples from three monitoring well boreholes, the open industrial outfall ditch and the west perimeter roadway. Table 7 is a summary of analytical data for water samples taken from all of the monitoring wells at George AFB. Laboratory data sheets are presented in Appendix F.

With the exception of Well CZ01, all of the monitoring wells including the existing USAF monitoring Well MW-1 were sampled the suite of parameters specified in the IRP Phase I records search report. These parameters include oil and grease, total organic carbon, phenols, chromium (Cr), lead (Pb), silver (Ag), chlorinated pesticides, purgeable halocarbons and purgeable aromatics. Because of the possible presence of polychlorinated biphenyls (PCBs) in spilled transformer oils, groundwater samples from Well CZ01 were analyzed for oil and grease, total organic carbon and PCB (Aroclor) 1242, 1248, 1254 and 1260. The environmental significance of these chemical parameters include:

Table 6

SUMMARY OF ANALYTICAL DATA FOR SEDIMENT SAMPLES FROM GEORGE AIR FORCE BASE[a]

Sample #	PCB (mg/kg)	Oil & Grease (mg/kg)	Phenols (mg/kg)	Chromium (mg/kg)	Lead (mg/kg)	Silver (mg/kg)	Haloscan (mg/kg)	Chlordane (mg/kg)	DDT/ DDD/ DDE (mg/kg)	Moisture (%)
Lab Detection Limit	(0.020)	(5.0)	(0.20)	(2.0)	(3.0)	(0.8)	(Note b)	(0.020)	(0.020)	NA
CZ01-050.5-051.5	ND	100								1.3
CZ01-070.5-071.5	ND	89								12
CZ01-140.5-141.5	ND	+								22
PR01		150								10
PR02		100								--[d]
ID01		200	0.2	2	<3[c]	ND	ND	ND	ND	3
ID02		140	0.2	10	<3	ND	ND	ND	ND	6
ID03		120	ND	6	<3	ND	ND	ND	ND	6
ID04		180	ND	9	<3	ND	ND	ND	ND	8
ID05		170	ND	3	ND	ND	ND	ND	ND	3
ID06		90	0.4	11	<3	ND	ND	ND	ND	7
ID07		250	ND	9	4	ND	ND	ND	ND	4
SZ02-055-056		100	0.23	20	<3	<0.8	ND	ND	ND	35
SZ02-075-076		96	ND	34	8	ND	ND	ND	ND	22
SZ02-095-096		+	ND	11	<3	ND	ND	ND	ND	16
NZ05-086.0-086.4		140	ND	19	<3	ND	ND	ND	ND	17
NZ05-115.5-115.85		+	ND	<2	<3	<0.8	ND	ND	ND	3
NZ05-135.9-136.4		130	ND	20	4	ND	ND	ND	ND	18

+ Insufficient sample for entire analysis.

[a]All sample analyses reported on a dry weight basis.

[b]Detection limits are: 0.5 organic chlorides; 0.1 organic bromide; 0.05 organic iodide.

[c]"Less than" symbol denotes presence of analyte below quantifiable concentration.

[d]Not measured on resample for oil and grease.

Table 7

SUMMARY OF ANALYTICAL DATA FOR GROUNDWATER SAMPLES
FROM GEORGE AIR FORCE BASE

Well ID	Oil & Grease (mg/1)	Phenols (mg/1)	TOC (mg/1)	Cr (mg/1)	Pb (mg/1)	Ag (mg/1)	DDT/ DDD/ DDE (μg/1)	Chlor- dane (μg/1)	Organic Chloride (mg/1)	Organic Bromide (mg/1)	Organic Iodide (mg/1)	PCB 1242 (μg/1)	PCB 1248 (μg/1)	PCB 1254 (μg/1)	PCB 1260 (μg/1)
Limit*	(0.5)	(0.004)	(2.0)	(0.01)	(0.01)	(0.003)	(0.10)	(0.10)	(0.002)	(0.002)	(0.002)	(0.20)	(0.20)	(0.20)	(0.20)
NZ01	ND	0.012	12	0.32	0.15	0.005	ND	ND	0.07	ND	0.12	--	--	--	--
NZ01[a]	(b)	0.009	8	0.29	0.14	0.005	ND	ND	0.06	0.003	0.020	--	--	--	--
NZ02	0.6	0.030	22	0.01	0.03	ND	ND	ND	0.29	0.008	0.006	--	--	--	--
NZ03	<0.5	0.007	27	0.18	0.26	0.007	ND	ND	0.07	0.016	0.005	--	--	--	--
NZ04	<0.5	0.015	3	0.01	0.11	ND	ND	ND	0.20	ND	0.032	--	--	--	--
NZ05	1.0	ND	5	0.10	0.13	ND	ND	ND	0.22	ND	0.020	--	--	--	--
SZ01	14	0.020	3	0.02	0.04	0.004	ND	ND	0.95	ND	0.062	--	--	--	--
SZ02	0.8	0.016	2	<0.01	0.02	0.003	ND	ND	0.51	ND	0.009	--	--	--	--
SZ02[a]	ND	<0.004	ND	0.09	0.06	<0.003	ND	ND	0.71	ND	0.008	--	--	--	--
SZ03	0.7	ND	5	0.04	0.06	0.003	ND	ND	0.80	ND	0.015	--	--	--	--
SZ04	<0.5	ND	4	0.10	0.07	0.005	ND	ND	1.10	ND	0.003	--	--	--	--
CZ01	1.3	--	6	--	--	--	--	--	--	--	--	ND	ND	ND	ND
CZ01[a]	--	--	--	--	--	--	--	--	--	--	--	ND	ND	ND	ND
MW-1	(b)	0.014	3	ND	0.01	0.003	ND	ND	0.03	ND	0.022	--	--	--	--

*Lab Detection Limit

[a]Denotes QA/QC sample.

[b]First sample aliquot contaminated during analysis--unable to analyze. Second sample aliquot broken during shipment.

- Oil and grease - Any petroleum or oil-based substance. The presence of oil and grease residuals in sediments or groundwater may be an indicator of past landfill, spill or disposal practices of fuel, waste oils or lubricants.

- Total organic carbon (TOC) - A measure of organic carbon content and an indicator of organic compound contamination in the groundwater. With respect to the suspected waste materials believed to have been disposed of at George AFB, it is an indicator of petroleums, lubricants, solvents, or landfill leachates.

- Phenols - Phenolic resins are used in fiber-bonding (e.g., laminates, composites) and in a wide variety of other adhesive applications. High-boiling phenols are used as solvents and as fuel-oil sludge inhibitors. Pentachlorphenol is widely used as a wood preservative in telephone poles, pilings, etc. Phenol and a number of other phenolic compounds have a low affinity for soil particles and therefore readily migrate in groundwater.

- Heavy metals (Cr, Pb, Ag) - Chromium enters the soil and groundwater through improper storage or disposal of industrial wastes from machining operations and landfill leachate. Lead can be an indicator of the intrusion into groundwater of industrial wastes, leaded fuels or landfill leachate. Silver is widely used in photographic applications.

- Chlorinated pesticides - Used extensively for control of insects and other pests and are generally both toxic and persistent. Pesticide contamination may be indicative of less than optimal pesticide application practices or failure to properly rinse pesticide containers prior to their disposal.

- Purgeable halocarbons and aromatics - Two groups of organic compounds (36 total compounds) which frequently are components in solvents, degreasing agents and industrial grade petroleum-based products commonly used for aircraft and engine maintenance and other base industrial applications. Table 8 is a list which identifies these organic compounds.

- Polychlorinated Biphenyls (PCB) 1242, 1248, 1254, 1260 - These highly toxic and persistent compounds are found in transformer oils and their occurrence in groundwater suggests improper storage or disposal of transformers or transformer oils.

4.4 DISCUSSION AND INTERPRETATION OF ANALYTICAL DATA

Measured concentrations of the compounds or pollutants of concern in the soils and groundwater beneath George AFB suggest low level contamination may be occurring in at least the northeast and southeast corners of the base. This contamination may be a result of past landfill disposal activities, past or current mission, and past industrial and storm water management practices.

Table 8

COMPOUNDS IDENTIFIED DURING PURGEABLE HALOCARBON EXTRACTION (EPA Method 601) AND PURGEABLE AROMATIC EXTRACTION (EPA Method 602)

Purgeable Halocarbons
(EPA Method 601)

Bromoform
Bromodichloromethane
Bromomethane
Carbon Tetrachloride
Chlorobenzene
Chloromethane
Chloroethylvinyl-ether, 2-
Chloroform
Chloroethane
Dibromochloromethane
Dichlorobenzene, 1,2-
Dichlorobenzene, 1,3-
Dichlorobenzene, 1,4-
Dichlorodifluoromethane
Dichloroethane, 1,1-
Dichloroethane, 1,2-
Dichloroethylene, 1,1-
Trans-1,2-dichloroethylene
Dichloropropane, 1,2-
Cis, 1,3-dichloropropene
Trans-1,3-dichloropropane
Methylene Chloride
Tetrachloroethane, 1,1,2,2-
Tetrachloroethylene
Trichloroethane, 1,1-
Trichloroethane, 1,1,2-
Trichloroethylene
Trichlorofluoromethane
Vinyl Chloride

Purgeable Aromatics
(EPA Method 602)

Benzene
Chlorobenzene
Dichlorobenzene, 1,2-
Dichlorobenzene, 1,3-
Dichlorobenzene, 1,4-
Ethyl Benzene
Toluene

These findings are based, however, on only one sampling event which allows no statistical certainty of results. However, the chemical data do indicate that there are no extremely contaminated soils or groundwaters, and that there is no imminent threat to base personnel safety or health, or the environment.

All analytical services were performed in accordance with EPA protocols. In general, duplicate sample analyses correlate well. An exception is groundwater collected in Well SZ02 from which the duplicates show considerable variation for the oil and grease, phenol, chromium and lead concentrations. ERG's laboratory is unable to identify any apparent cause for this lack of correlation. Based on the chemical results from the one sampling event, and field observations during site surveys, borehole drilling, and sample collection, the data suggest:

1. Low level oil and grease concentrations suggest chronic contamination of soils. Oil and grease analyses were performed using the partition-infrared method. This method uses the solvent trichlorotrifluoroethane to solubilize any organic matter, and is designed to contain volatile hydrocarbons that otherwise may be lost in the solvent removal operations of other analytical procedures. Surface soils, as expected, have generally higher oil and grease concentrations than deeper soils. The ubiquity of measurable oil and grease, and at concentrations that appear to be 80 mg/kg or above, suggest sources of contamination related to aircraft operations including takeoff and landings, low altitude flying, particulate or precipitation fallout of airborne hydrocarbons, and fallout of vaporized hydrocarbons from fueling and defueling activities.

2. Oil and grease concentrations in soil samples taken six inches below the surface of the west perimeter roadway (samples PR01 and PR02) do not exhibit concentrations significantly above background or the chronic low level contamination found elsewhere. The extremely compacted dirt road surface would not normally allow much penetration of fuel before it would volatilize in the hot desert sun. The sample sites may not have been in the area which received repeated fuel discharges. Reexamination of the IRP Phase I report following receipt of the soil chemistry data suggests that more frequent dumping of fuel may have taken place along the interior base road leading to the jet engine test cells.

3. Soil samples taken nearby or in the industrial drain and storm runoff outfall ditch northeast of the operations apron confirm low level contamination as measured by oil and grease residues. The samples analyzed were composites of discrete samples collected 5 and 10 feet below the sandy surface in the bottom of

the ditch. Figure 13 illustrates the locations of the soil samples taken from above, within or adjacent to the outfall ditch. Station ID01 was taken in the ditch upgradient from the flight operations apron industrial/storm drain primary outfall, but in the area which received raw fuel washdown from an aviation fuel truck accident several years previous to the field investigation. Figure 14 depicts the major storm drainage system in the operational apron area. Most of the street runoff is conveyed by streetside drainage ditches which flow towards and adjacent to 13th Street until they discharge into the head of the outfall drainage ditch (refer to Figure 13).

The head of the industrial-storm drainage ditch, near 13th and "A" Streets (see Figure 13), is the point of confluence of these streetside drainages. Thus the release of fuel or other product during a vehicle accident away from aircraft operations is likely to have found its way into the industrial/storm drainage ditch.

Stations ID02 through ID06 were in the bottom of the ditch and extend from immediately below the primary 24-inch outfall from the operational apron industrial/storm drain to the toe of the ditch in the hillside canyon at the north property line of the base. Finally, Station ID07 was located between Taxiway 10 and Runway 21 and alongside the drainage ditch which receives stormwater runoff from the most westerly aircraft operations, and from apron runoff which flows north and into a storm drain line on the northside of the apron that parallels the industrial/storm drain line noted in Section 3.8. Any vehicle washdown waters or storm runoff which enters the industrial outfall ditch from the storm sewer beneath the operational apron pass through an oil-water separator on the primary 24-inch outfall line prior to discharge (see Figure 13). During high flow conditions, however, storm line surcharge will overflow into the secondary 24-inch outfall and bypass any oil-water separation.

Soil data taken in the outfall ditch (Site S-20) confirm oil and grease contamination. Sample ID07 exhibits the highest concentration of oil and grease, perhaps reflecting that no oil-water separator stands between the storm drain and the grassed area between the runways into which this storm water discharges. Two distinct concentration gradients are suspected in the long outfall ditch east of Taxiway 10. The first gradient extends from Stations ID01 to ID03. The first gradient is likely a result of the fuel truck accident or other surface runoff combined with industrial/storm drain outfall discharges. The second gradient extends from Stations ID04 to ID06. This second gradient is likely the result of the added flightline storm water discharge (i.e., as sampled at Station ID07) into the industrial outfall ditch.

4. Oil and grease data for groundwater samples (Table 7) taken from the monitoring wells exhibit a range of values between none detected and 1.3 mg/l except for Well SZ01 whose concentration of oil and grease is 14 mg/l. SZ01 is the deepest monitoring well

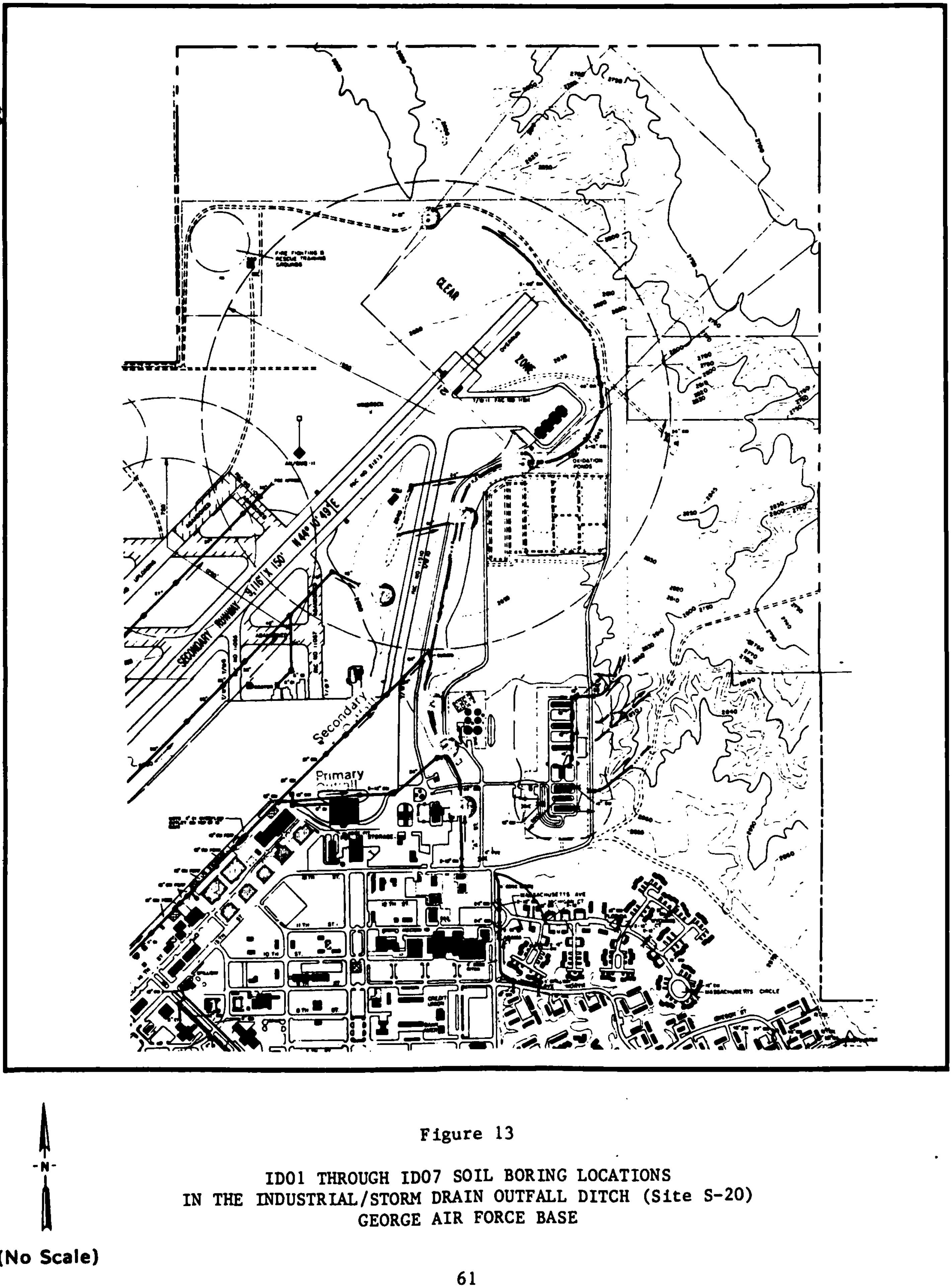
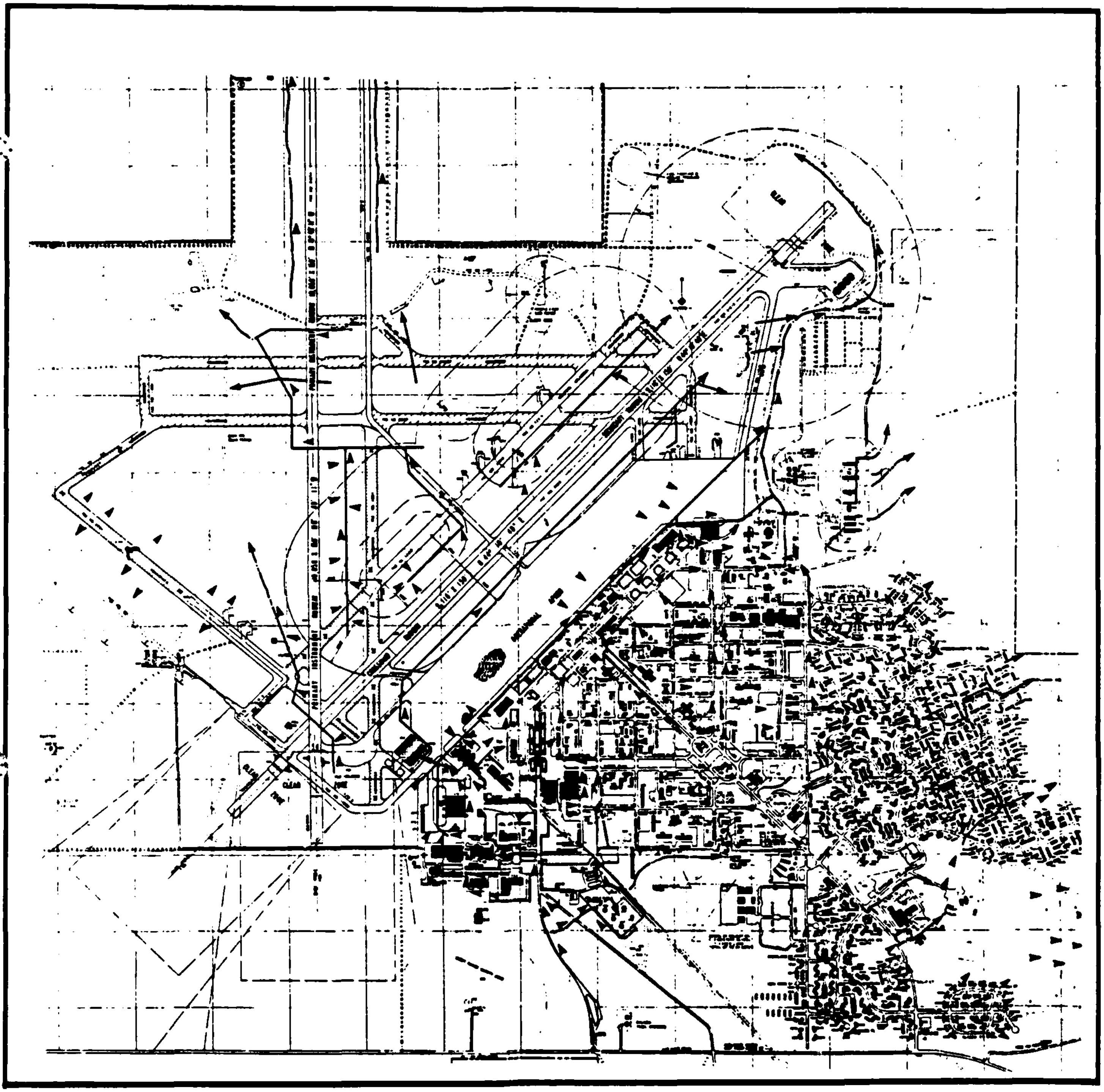


Figure 13

IDO1 THROUGH IDO7 SOIL BORING LOCATIONS
IN THE INDUSTRIAL/STORM DRAIN OUTFALL DITCH (Site S-20)
GEORGE AIR FORCE BASE



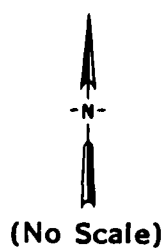


Figure 14

SURFACE DRAINAGE SYSTEM AT GEORGE AIR FORCE BASE
(Source: Tab G-3)

installed during this investigation and is upgradient of all base facilities and landfills, waste disposal or spill sites. This high concentration of oil and grease is not anticipated given the well's location. The high-measured oil and grease concentration is inconsistent with the measurably low COD and heavy metal concentrations. This inconsistency and the fact that there is no known local source of oil or grease contamination warrants resampling of the groundwater. Wells CZ01 and NZ05 have the next highest concentrations of oil and grease at 1.3 and 1.0 mg/l, respectively. Both of these wells are nearest to known fuel disposal dry wells or areas with large rates of fuel use. These wells should be resampled to confirm the contaminant levels.

5. Total phenols were measured at trace concentrations in three outfall ditch soil samples, in the borehole soils at one well downgradient of the southeast landfills, and at 30 ppb or less in seven groundwater monitoring wells. There is no known explanation for the presence of phenols throughout the base. However, the base is planning to chlorinate its water supply and the California Department of Health Services has recommended an action level of 0.001 mg/l for chlorinated supply systems based on the taste and odor threshold. Resampling of groundwater should be accomplished to confirm the presence of phenol and to identify its source.

6. Total organic carbon (TOC) was measured in all groundwater monitoring wells at concentrations generally less than 5 mg/l (see Table 7). The highest reported concentrations (22-27 mg/l) were found in Wells NZ02 and NZ03, both hydraulically downgradient of the northeast landfills and all other base activities, and both drilled using mud rotary techniques. Well NZ01 at the north end of the outfall ditch also contains elevated TOC. All wells need to be resampled to confirm the COD data (also on Table 7) which could indicate the migration of leachate and other landfill residues into Wells NZ02 and NZ03. Chemical oxygen demand (COD) as measured in Well NZ01 is likely a result of storm water contaminant load and percolation into the floor of the outfall ditch as it widens near the north boundary of the base. However, the COD could indicate groundwater contamination as a consequence of the active fire training area (Site S-5) located about 1,500 southwest (and hydraulically upgradient) of the well location.

7. The data suggest possible chromium and lead contamination in the industrial outfall ditch, and in groundwaters downgradient of the northeast and southeast landfills. Well NZ01 has the highest measured chromium concentration in the groundwater at approximately 0.31 mg/l. This is six times the EPA drinking water standard (see Table 9). This same well has lead at 0.15 mg/l, three times the drinking water standard. Wells NZ03, NZ05, SZ02, and SZ04 have chromium and lead concentrations above the 0.05 mg/l EPA water quality standard. Wells NZ04 and SZ03 also exceed the allowable lead concentration. All of the measurements represent total metal concentration, which includes both particulate and dissolved metals. The monitoring wells should be resampled and heavy metal analyses conducted on filtered water samples.

Table 9

EPA DRINKING WATER STANDARDS

National Interim Primary Drinking Water Regulations
40CFR141 (48FR8413, February 29, 1983)

Contaminants	MCL,[a] mg/1
Arsenic	0.05
Barium	1.0
Cadmium	0.01
Chromium	0.05
Fluoride	1.4-2.4[b]
Lead	0.05
Mercury	0.002
Nitrate (as D)	10.0
Selenium	0.01
Silver	0.05
Turbidity Units	≤5 NTU[c]
Coliform Bacteria	≤4/100 ml[c]
Endrin	0.0002
Lindane	0.004
Methoxychlor	0.1
Toxaphene	0.005
2,4-D	0.1
2,4,5-TP Silvex	0.01
Total trihalomethanes	0.1

National Secondary Drinking Water Regulations
40CFR143 (44FR42198, July 19, 1979)

Contaminants	MCL,[a] mg/1
Chloride	250
Color	15 color units
Copper	1.0
Corrosivity	noncorrosive
Foaming Agents	0.5
Iron	0.3
Mangenese	0.05
Odor	3 threshold odor number
pH	6.5-8.5
Sulfate	250
Total Disolved Solids (TDS)	500
Zinc	5

National Primary Drinking Water Regulations, Proposed for Volatile Synthetic Organics, 40CFR141
(49FR24330, June 12, 1984)

Contaminant	RMCL,[d] mg/1
Benzene	0.0
Carbon Tetrachloride	0.0
1,4-dichlorobenzene	0.75
1,2-dichloroethane	0.0
1,1-dichloroethylene	0.0
Tetrachloroethylene	0.0
1,1,1-trichlorethane	0.2
trichloroethylene	0.0
vinyl chloride	0.0

(a) Maximum Contaminant Level
(b) Inversely proportional to water temperature
(c) Variable, based upon sampling frequency
(d) Recommended Maximum Contaminant Level

8. Silver was measured in most groundwater samples and was detected but not quantified in two soil samples. In all water samples, the measured silver concentration was almost always equal to or less than 10 percent of the allowable 0.05 mg/l drinking water standard. A poor recovery rate (33 percent) as determined by laboratory QA/QC may be due to the presence of inorganic chlorides. The laboratory was contacted regarding the low spiked sample recovery rate and cannot explain why EPA protocols, which require immediate rerun of the analyte, were not followed. Groundwaters should be resampled to confirm these low numbers before dismissing silver as a contaminant of concern.

9. No chlorinated pesticides or polychlorinated biphenyls were identified in any of the groundwater or soil samples. Resampling should be accomplished prior to dismissing either class of synthetic organics as contaminants of concern.

10. The total halogenated hydrocarbon analyses report the combined presence of organic chlorides, bromides, and iodine only in the most northerly Wells NZ01 through NZ03. In all other groundwater samples analyzed, only organic chlorides and organic iodines were identified. The frequent and elevated presence of chlorinated organics suggests possible contamination by solvents or other industrial chemicals. Additional monitoring is recommended.

11. Groundwater specific conductance and temperatures as measured in mid-June 1984 are presented on Table 10. Temperatures are generally uniform across the base and in the range of 21 to 22°C. However, groundwater is cooler by as much as five degrees in Well MW-1 and Wells NZ02 through NZ04. All wells are close to each other and hydraulically downgradient of the operational apron, suggesting that surface activities, including irrigation and equipment and aircraft washdown, may influence the aquifer in the northeast corner of the base.

12. Across the base specific conductance is approximately 450 to 500 micromhos/cm unless influenced by some surface activities or buried wastes. Specific conductance data shows noticeably increased conductivity in Wells NZ04, NZ05 and the old monitoring Well MW-1. Specific conductance more than doubles from Well CZ01 to Well NZ04. The three wells with elevated specific conductance are downgradient of the industrial flightline activities and, in the case of MW-1, also downgradient of the old treatment plant percolation ponds. Industrial/storm drain exfiltration may be carrying pollutants into the groundwater which is now being detected by increasing specific conductance in Wells NZ05 and NZ04. Similarly, percolation in the industrial ditch may be carrying contaminants into groundwater which accounts for the increased conductance in Well NZ01.

13. The southeast landfill activities appear to be exerting a slight influence on groundwater specific conductance. There appears to be a correlation with specific conductance and the location of the wells downgradient of the landfills. Well SZ02, downgradient

Table 10

SPECIFIC CONDUCTANCE AND TEMPERATURE DATA
FOR MONITORING WELLS AT GEORGE AIR FORCE BASE
(June, 1984)

Well ID	Specific Conductance @ 25°C (µmhos/cm)	Temperature (°C)	
		Bottom	20 feet Above Bottom
CZ01	510	21.6	21.6
NZ01	875	20.4	20.2
NZ02	540	19.2	19.2
NZ03	625	18.9	18.9
NZ04	1100	21.1	16.6
NZ05	750	21.6	21.6
SZ01	450	21.4	21.3
SZ02	450	22.2	21.9
SZ03	480	21.7	21.6
SZ04	490	21.3	21.2
MW-1	950	16.9	16.9

of all landfills, has the highest specific conductance. Conductivity decreases across Wells SZ03 and SZ04, each with a smaller percentage of landfill mass hydraulically upgradient of the well screen. Finally, the northeast landfills would appear to be only influencing the groundwater near Well NZ03 as specific conductance has increased by 30 percent. However, this well is also in line with the CZ01, NZ05, NZ04 and MW-1 set of wells described above in conjunction with possible flightline contamination sources.

In summary, there are indications of soil and groundwater contamination as measured by chromium, lead, total organic carbon, specific conductance, oil and grease, and halogenated hydrocarbons. Most contaminant concentrations are at low levels and do not now pose any immediate threat to personnel safety or health or the environment. There are no detectable traces of PCB wastes or pesticide residues. The areas most prone to low level contamination are the eastern one-half of the industrial activities near the operations apron, the induistrial/storm drain and outfall ditch, and the northeast landfill. Most sampling stations should be reoccupied to confirm the results.

4.5 DISCUSSION OF INDUSTRIAL PIPELINE EXFILTRATION TEST

A plan and cross-sectional diagram of the 3,400 feet of industrial/storm drain tested for exfiltration is presented in Figure 15. This plan was developed from Utility Drawing G-3 and field notes; it identifies the points of placement for the mechanical plugs. All water level gauging was accomplished in Manholes A through E. Pipeline exfiltration test results and interpretations of the water loss data are presented in Appendix G (Tables G-1 through G-5). Figures G-1 through G-4 present side profiles of the lines when undergoing water filling and exfiltration. The volume of water lost to exfiltration within each line segment is shown as a shaded zone in the line segment profiles.

A summary of exfiltration rates for each of the line segments is presented in Table 11. The theoretical rates of exfiltration have been expressed as gallons per day per inch-diameter of pipe per lineal foot (gpd/in-diam/ft). This unit of expression allows all values to be normalized to a single unit and corrects for varying pipe diameters. Table 11 confirms the field findings that all drain line segments lost water during the study period, but that the water

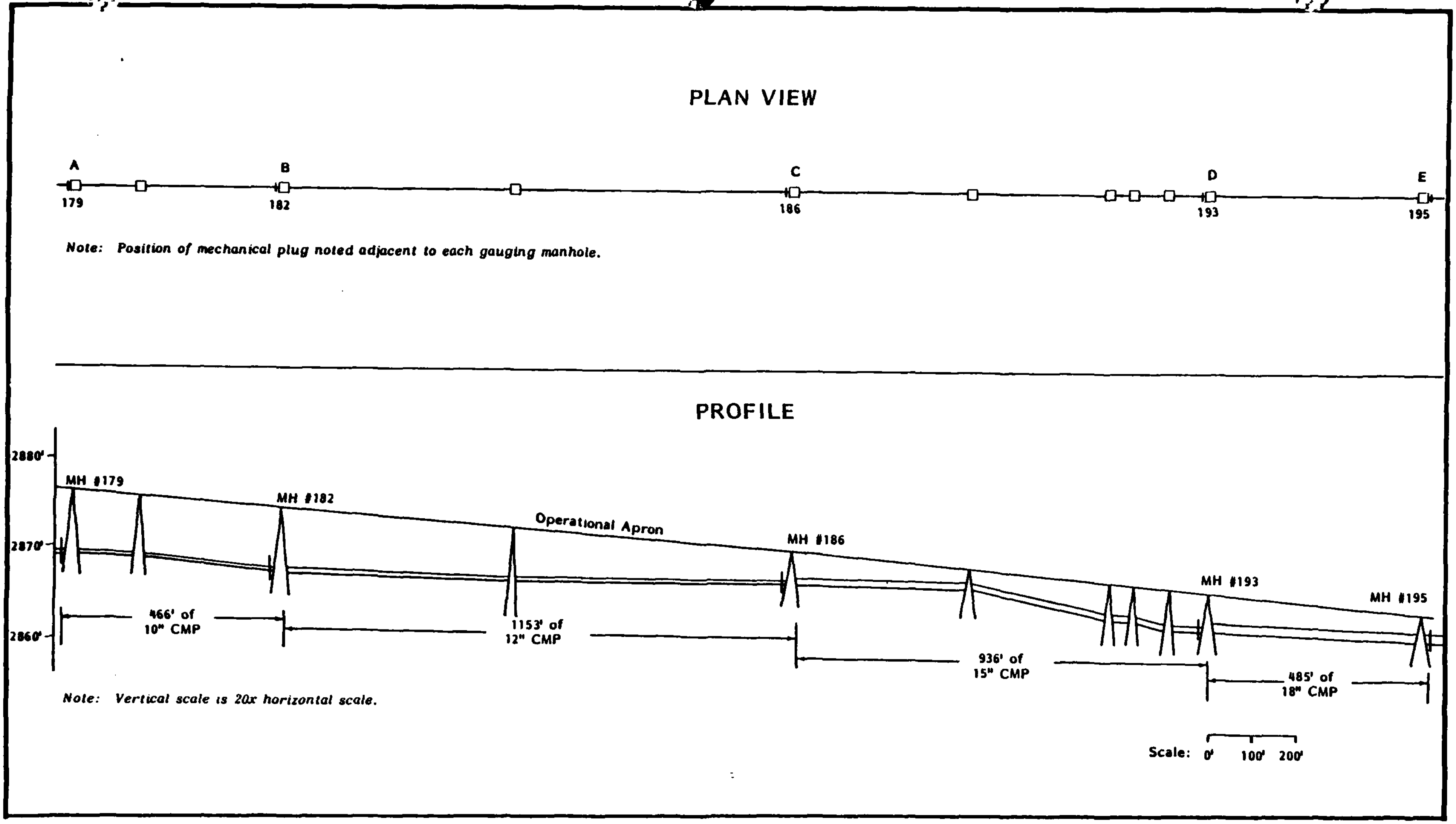


Figure 15

PLAN VIEW AND CROSS-SECTIONAL DIAGRAM OF INDUSTRIAL/STORM DRAIN
BENEATH GEORGE AIR FORCE BASE OPERATIONAL APRON
(Source: George AFB Utility Drawing G-3 and Storm Drainage Schedule)

Table 11

EXFILTRATION TEST RESULTS OF THE INDUSTRIAL/STORM DRAIN (SITE S-20)
AT GEORGE AIR FORCE BASE, CALIFORNIA

Line Segment	Pipe Diameter	Length	Emperical Exfiltration Rate[a] (gpd/in-diam/ft)	Projected Exfiltration Volume (gpd)		
				0.1 diam	0.3 diam	1.0 diam
AB	10"	466'	0.552	514	951	2,570
BC	12"	1153'	30.34	83,960	155,326	419,800
CD	15"	936'	0.758	2,129	3,939	10,645
DE	18"	485'	0.507	886	1,639	4,430

[a] For comparative purposes, contemporary sanitary sewer design allows an exfiltration rate of 0.05 to 0.10 gpd/in-diam/ft for gasketed bell-and spigot pipe.

loss in line segment B-C was much greater than any of the other segments tested. Line segment B-C lost water at such a rapid rate that it was impossible to even fill the line and upstream manhole as was established for the test procedure. Table 11 also presents an estimate of water exfiltration volumes which would be lost during any given day when the lines are flowing at depths equal to 10, 30 and 100 percent of pipe diameter. Due to the slopes of the sewers it is most probable that these lines would seldom flow deeper than 30 percent of line diameter. At that depth, 37 percent of the pipe circumference is wetted and subject to exfiltration.

Based on the low level and closeness in computed exfiltration rates for line segments A-B, C-D, and D-E it is postulated that only line segment B-C contains many reaches of perforated corregated metal pipe. The lower computed values are more likely to represent exfiltration through pipe joints. All rates themselves are artificially high in that flooding of the line segments allowed the total pipe circumference to become wetted. In addition, it is most probable that the pipe bedding in direct contact with the lower 50 percent of pipe circumference has become more plugged with fine grained silts and petroleum residues than pipe cover materials. These tighter bedding soils would tend to further reduce the actual rates of exfiltration under normal flow conditions.

4.6 REVIEW OF DATA FOR JET FUEL PIPELINE AND STORAGE TANK SYSTEM

The review of available USAF pressure test data and other leak test data for the jet fuel pipeline and storage tank system consisted of interviews with the foreman of the Liquid Fuels Shop at George Air Force Base, the Environmental Planner, and the quality control inspector for the POL Management system. The Liquid Fuels Shop is directly responsible for the maintenance and pressure testing of the 25,000 feet of both underground and aboveground pressurized jet fuel pipelines at George AFB. Figure 16 is a plan of the liquid fuel system at George AFB. JP-4 avaiation fuel is delivered to the base by pipeline from CALNEV bulk fuel storage tanks near Air Base Road. The fuels are stored in five government-owned bulk storage tanks with a combined capacity of 55,000 barrels. A pumping station consisting of four 2-stage turbine pumps is available to transfer fuel to intermediate fuel storage tanks near the operational apron. As many as three pumps can be used concurrently to transfer fuel at an

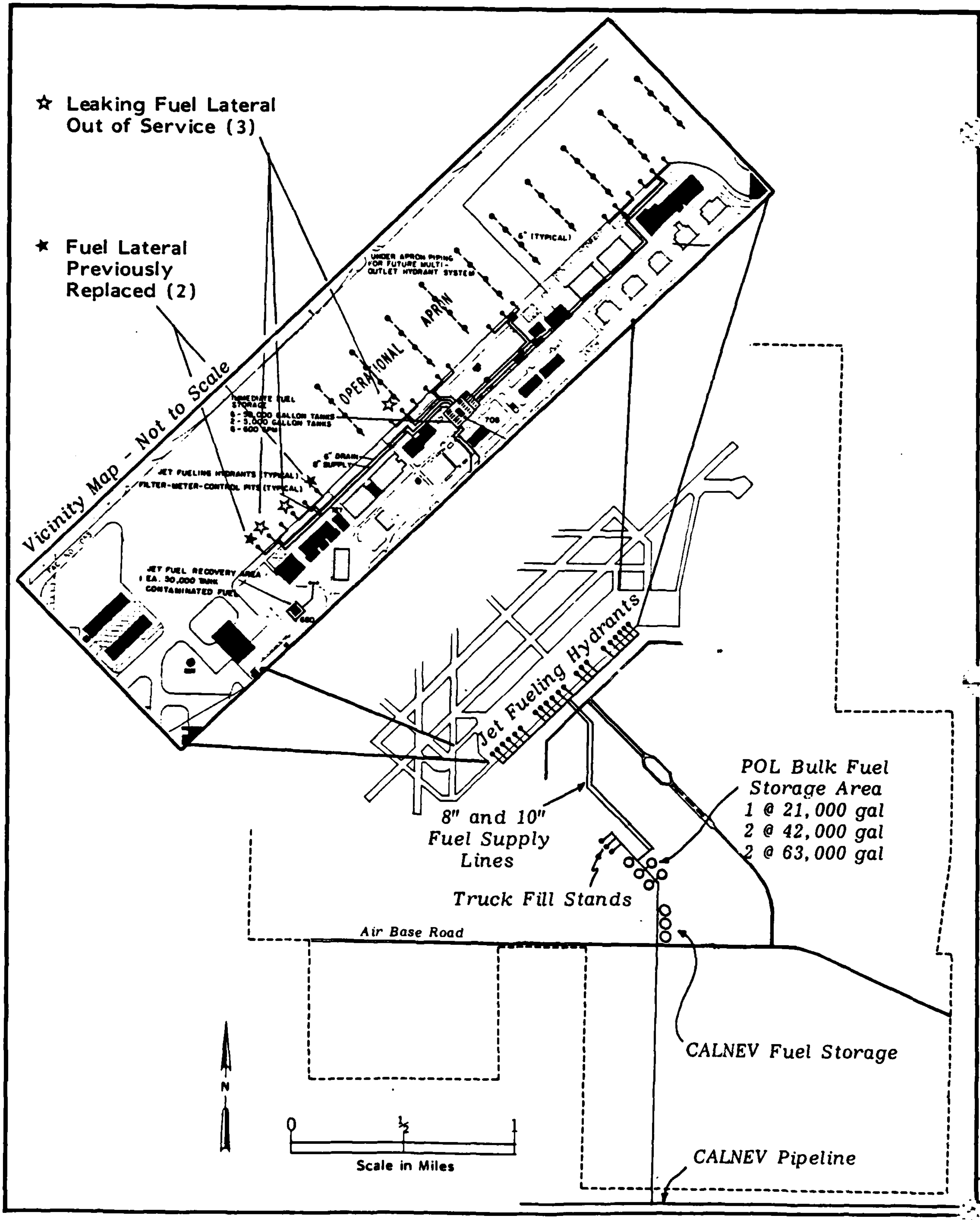


Figure 16

SIMPLIFIED PLAN OF LIQUID FUEL SYSTEM AT GEORGE AIR FORCE BASE

operating flow rate of 1,100 gpm. However, base personnel have found that gravity flow through the 8-inch and 10-inch fuel transfer lines will produce a fuel transfer rate of 1,700 gpm. Hence, the pumps are not now used except to pressurize the system above the 15 to 20 psig obtained under gravity flow conditions. All major fuel distribution pipelines are constructed of 8- and 10-inch steel pipe wrapped with felt and coated with tar.

Sacrificial anodes are emplaced on each of the two major fuel lines near the bulk fuel storage tanks and again halfway between bulk storage and intermediate storage. The majority of the pipeline system is buried approximately seven feet below the ground surface. Intermediate fuels storage is accomplished in underground tanks. Fuel is pumped to seven filter and metering pits. Three laterals extend from each pit.

Pipeline pressure tests are performed once each year. These lines, each approximately 1,800 feet in length, have a combined storage capacity of about 12,000 gallons. Liquid Fuels Shop personnel perform the test by pressurizing the lines for 12 to 24 hours to a design operating pressure of 100 psig. A decrease in the pressure of the system which is greater than three to five psig over the test period indicates a potential problem. A small pressure drop will first be evaluated to determine if valves were not fully closed or if fuel was leaking back through the pumps. The tests are then repeated to confirm the leak. If the leak is determined not to be associated with the valves or pumps but instead the pipe itself, an inspection or other testing would be initiated. According to the shop foreman there have been no leaks or problems with the pressurized system for the 20 years since he first came to George AFB. The foreman also stated that no records are kept of yearly pressure testing of the pipelines, but merely of corrective maintenance actions. However, a physical inspection of the pipeline system was performed by the USAF Engineering Services Center in about 1980. This inspection included excavation and temporary removal of felt and tar coatings and showed the pipeline to be relatively free of corrosion and in very good condition.

The George AFB Environmental Planner described a historical problem of leaking low-point drains in the pressurized fuel pipeline system. Low-point drains are used to drain condensate and particulate accumulations at 21 points along

the pipeline. The drains were constructed of unwrapped uncoated black iron pipe. Several years ago an inspection of the drains revealed that most of them were badly corroded and five of the drains were leaking. The leaky drains were all replaced and all 21 drains were wrapped with felt and coated with tar. There is no record of contaminated soil excavation and disposal.

The quality control inspection stated that there have been detected or suspected leaks in five of the 21 laterals serving the operational apron (see Figure 16). Two of the laterals had failing hose connectors at the surface of the apron and were replaced in the late 1970s. There was no known fuel loss associated with the bad hose connectors. Three other laterals, however, were found in late 1983 to be cracked and leaking after examination of fuels inventory records and pressure testing of the lines. These laterals are located along the west half of the operational apron and in the vicinity of those sections of the industrial/storm drain which contained oil stained sediments and also had the highest rates of exfiltration. The laterals were taken out of service in 1983 once the fuel leaks were confirmed. The estimated quantity of fuels lost is not known. The lines remain out of service and, together with the other 18 operating fuel laterals, are scheduled to be decommissioned once the fuel hydrants beneath the operational apron are connected to the fuel filtering and metering system. These buried lines, though installed in 1967, have recently been tested and have been determined to be in good condition.

4.7 SUMMARY OF RESULTS AND FINDINGS

In continuance of the USAF Installation Restoration Program at George AFB, a Phase II, Stage I (Confirmation) Investigation was performed to evaluate groundwater flow and quality, and to characterize chemical compounds found in the soils and groundwater beneath suspected areas of waste disposal on the base. Additionally, an exfiltration test was performed on an industrial/storm drain line beneath the operational apron, and liquid fuel system pressure test data were reviewed. These services have been completed and the following conclusions are presented.

4.7.1 General Conclusions

George AFB is a Tactical Air Command facility with limited industrial maintenance operations taking place on base. The primary mission of the base is to

execute tactical fighter operations and to provide aircrew and maintenance training. As a consequence, industrial waste generation, storage and disposal problems are less in number and significance when compared to bases with large maintenance facilities. On-base landfills are suspected to contain a variety of materials ranging from domestic solid wastes to containers for pesticides, paint, acids, and aircraft parts. During the IRP Phase I records search it was discovered that the south base landfill served as a possible burial site for containers of tetraethyllead, low-level radioactive wastes and drums of acetone.

A total of 10 new groundwater monitoring wells were constructed on the base during these investigations. Soil type and water table elevations, together with comparable data from USAF monitoring Well MW-1 near the old wastewater treatment plant and water supply wells south and west of the base (see California Department of Corrections, 1983), enable us to offer the following general conclusions:

1. The depth to groundwater in the vicinity of George Air Force Base varies from 170 feet below the ground surface on the south base property line to approximately 120 feet below the ground surface near the runways. Groundwater is no less than 90 feet below the surface in topographic lows in either the southeast or northeast corners of the base.

2. Regional groundwater flows southwest to northeast with a gradient of approximately 17 feet per mile as determined between Wells CZ01 and NZ04. A localized tilt in the water table of 200 feet per mile in an easterly direction occurs in the vicinity of the steeply sloped northeast landfill. These large gradients can only occur because of tight soils and low water yield. As a consequence, the horizontal velocities of groundwater flow would be very slow. Assuming a hydraulic conductivity of approximately 10 gallons per day per square foot in the fine silty sands, the horizontal velocity of groundwater on the upper plateau is estimated to be 0.25 feet per day.

3. Almost all deep borings confirmed the presence of a clay-rich lens approximately 60 to 70 feet below the ground surface and at an attitude concomitant with the slope of the land.

4. Trace or low-level organic and heavy metal contaminants have been measured in surface soil and groundwater samples. This suspected contamination must be confirmed and quantified prior to drawing positive conclusions as to possible sources and fate.

4.7.2 Area and Site Specific Conclusions

IRP Phase II, Stage I (Confirmation) field investigations were performed in five geographic areas on George AFB which encompassed or were in the immediate proximity of 17 of the 23 waste disposal sites ranked by HARM methodology in the IRP Phase I records search. An additional two sites (of 31 total) not ranked by HARM are also within the boundaries of the areas investigated. Figure 17 identifies the five study areas and the location of all newly installed groundwater monitoring wells, soil sampling stations, and the existing base monitoring Well MW-1. Soil and groundwater chemistry data indicate low level contamination in several areas. In some instances there appears to be a cause-effect relationship between past waste disposal practices and observed soil and groundwater contaminant concentrations which cannot be confirmed without additional testing. Table 12 presents a summary by study area of all field activities, chemical characterizations, and general findings and conclusions. More specifically, the results of the field investigations enable us to conclude:

1. Exfiltration testing of the industrial/storm drain beneath the operational apron (Site S-20) indicates very high rates of water loss across the 1,153 foot section of 12-inch diameter corregated metal pipe between Manholes #182 and #186. Exfiltration across other lengths of drain line are two orders of magnitude lower. In the absence of televising the line, it is our belief that most if not all perforated pipe lies between the above manholes. Under normal runoff conditions, when the line does not flow abnormally full, exfiltration rates may be less than those measured due to a lesser wetted pipe circumference and silt accumulation in the pipe invert. It is also probable that low flow pipe exfiltration is reduced further by pipe bedding material partially clogged with fine silt and oils and greases from past activities along the operational apron.

2. Air Force records as reported in the IRP Phase I study confirm that all known wastewater discharges to the industrial/storm drain have been disconnected or plugged. Oil and fuel-stained sediments were observed in all pipe inverts and were deeper than 12 inches in several manholes. The source of these materials are believed to be related to surface activities on the operational apron or adjacent vehicle wash racks. An additional source may be soil contamination due to leaking JP-4 fuel laterals extending from fuel filtering Pits No. 1 and No. 2 between drain line Manholes #179 and #184. Groundwater and outfall ditch soil chemistry downgradient of the drain line and flightline maintenance activities suggest low level contamination by oils and greases, halogenated hydrocarbons, and heavy metals. The sources of these contaminants

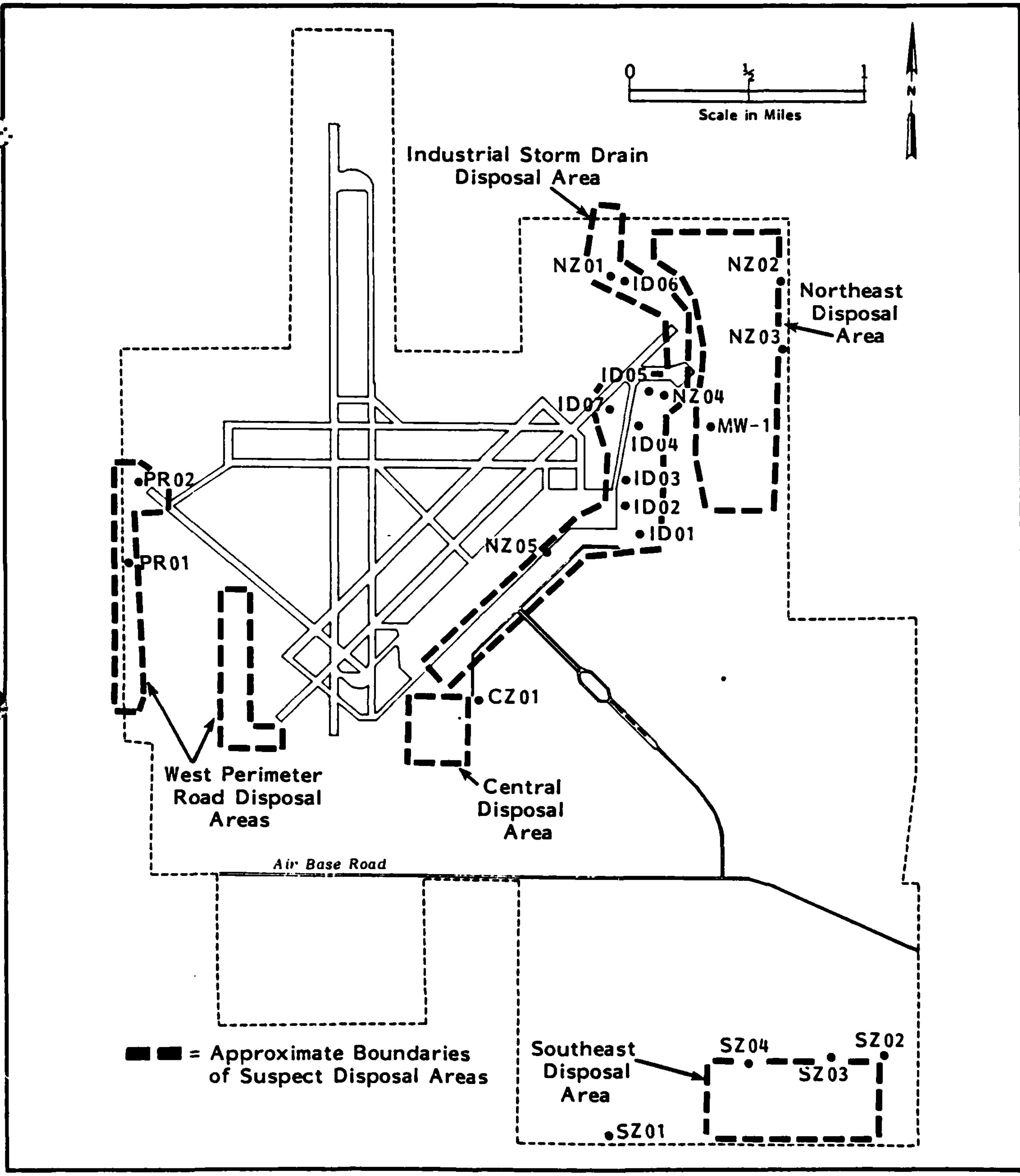


Figure 17

LOCATOR MAP FOR ALL IRP PHASE II MONITORING WELLS, SHALLOW
SOIL BORINGS AND SURFACE SOIL SAMPLING SITES
GEORGE AIR FORCE BASE

Table 12

SUMMARY OF IRP PHASE II (CONFIRMATION) INVESTIGATIONS AT MAJOR DISPOSAL SITES GEORGE AIR FORCE BASE

Area	Site	Phase I Harm Score	Field Activities	Chemical Characterizations	Summary of Findings
N/A	S-20 Industrial/ Storm Drain and Outfall Ditch	60	• Site inspection • Sewer line exfiltration • Outfall ditch soil sampling (7 samples @ 5-10 ft deep)	• Oil and grease in 7 samples, range: 90-250 mg/kg • Measurable chromium in 7 samples, range: 2-11 mg/kg • Trace phenol in 3 samples • No pesticide or halogenated hydrocarbons	• Confirmed contamination • Two concentration gradients • Operational apron storm drains (north and south) suspected source of ongoing contaminant loading • Historical fuel spill suspected source of contamination
Northeast	B-8 Pesticide and Paint Burial B-9 Acid and Oil Burial B-10 Pesticide and Oil Burial L-11 Street Sweeping Disposal L-12 Original Base Landfill L-13 Base Landfill S-6 Abandoned Fire Training Area S-21 STP Percolation Ponds S-25 Sludge Drying Beds	36 37 36 40 42 49 47 42 43	• Site inspection • 5 monitoring wells • Well monument survey • Reoccupy existing monitoring well • Borehole soil sampling (1 borehole, 3 samples) • Groundwater sampling (6 samples, 1 per well) • Depth-to-water measurements	• Oil and grease (130 mg/kg) in soils at depth • Oil and grease in groundwater (≤1.0 mg/l) • Apparent chromium contamination in soil (<20 mg/kg) and groundwater (≤0.32 mg/l) • Apparent lead (≤0.26 mg/l) and silver (≤0.007 mg/l) contamination • Measurable phenol (≤0.03 mg/l) halogenated hydrocarbons (≤0.4 mg/l) in all groundwater samples • Elevated TOC downgradient of landfill (≤27 mg/l) • No measurable pesticides • Elevated specific conductance downgradient of operational apron	• Confirmed contamination at east end of industrial operations area, downgradient of northeast landfills, and downgradient of fire training area • Groundwater chromium and lead concentrations exceed drinking water quality criteria • Landfill leachate potential impact on groundwater
Central	S-19 Transformer Oils S-22 French Drain (dry well) S-23 French Drain (dry well)	N/A 42 40	• Site inspection • 1 monitoring well • Well monument survey • Borehole soil sampling (1 borehole, 3 samples) • Groundwater sampling (1 sample, 1 well) • Depth-to-water measurement	• Oil and grease (100 mg/kg) in soils at depth • Oil and grease in groundwater (≤1.3 mg/l) • No measurable PCBs in soils or groundwater • Elevated TOC (6 mg/l) in groundwater	• Suspected hydrocarbon contamination of soil and groundwater • No demonstrated release of PCB contaminants
West Perimeter Road	S-4 Fuel and Oil Disposal	44	• Site inspection • Road surface soil Sampling (2 @ 6" below surface)	• Measurable oil and grease on road surface	• Suspected contamination
Southeast	L-1 Base Landfill L-2 TEL Disposal Site L-3 Radioactive Disposal L-4 Munitions Disposal/Starter Cartridges M-2 Small Arms Residue/Oil	50 45 36 N/A 38	• Site inspection • Magnetometer survey (10'x10' grid; 19,208 stations) • 4 monitoring wells • Well monument survey • Borehole soil sampling (1 borehole, 3 samples) • Groundwater sampling (4 samples, 1 per well) • Depth-to-water measurements	• Oil and grease contamination in soils (≤100 mg/kg) • Measurable oil and grease in groundwater (≤14 mg/l) • Chromium (≤34 mg/kg) and lead (≤8 mg/kg) contaminants in soil • Chromium (≤0.1 mg/l), lead (≤0.07 mg/l), and silver (≤0.05 mg/l) in groundwater • Halogenated hydrocarbons (≤1.1 mg/l) in groundwater	• More than 30 trenches with metal wastes • TEL wastes may be buried west of landfill • Measurable chlorinated organics in groundwater; concentration gradient with highest contaminants near suspected TEL disposal site • Elevated concentrations of heavy metals in groundwater
N/A	B-2 Paint Drum Burial S-1 POL Leach Field S-3 POL Leach Field S-5 Fire Training Area S-7 Tip Tank Drainage Area	36 34 34 47 45	• None to date	• None to date	• None to date

include water exfiltration from the drain line, surface spills and accidental discharges of liquid fuels, and possibly unknown releases of industrial wastes.

3. Borehole soil and groundwater chemistry in the vicinity of northeast disposal sites indicate contamination by oils and greases, chlorinated hydrocarbons, and heavy metals. Current heavy metal data suggest violation of drinking water criteria. Additional testing is needed to confirm heavy metal concentrations in filtered groundwater. Groundwater temperatures and specific conductance measurements suggest that flightline industrial operations and the industrial/storm drain exfiltration and its outfall ditch are probable sources and pathways of contamination, respectively. A potential source of hydrocarbon contamination that was not included in the Stage 1 (Confirmation) Investigation is the current fire training area (Site S-5) west of Well NZ01 which has measurable oils and greases, heavy metals, and halogenated hydrocarbons in the groundwater.

4. Borehole soils testing and groundwater monitoring in the central disposal area (Well CZ01) indicate the absence of measurable polychlorinated biphenyls (PCBs), but they identify an elevated concentration of oil and grease. The well was located at a point believed hydraulically downgradient of two brick-lined dry wells used for the disposal of waste oils and fuels. Additional monitoring must be accomplished to confirm the types and magnitude of contamination, and be expanded to include heavy metals and a broader scan of organic hydrocarbons.

5. Surface soil sampling in suspected waste fuel disposal areas along the west perimeter road indicate contamination by hydrocarbon residuals but at areally extensive background concentrations. A review of reported fuels discharges suggests that greater quantities of fuels may have been disposed on the road surface leading to the jet engine test cell.

6. Soil and groundwater monitoring data in the southeast disposal area suggest that chlorinated hydrocarbons, oils and greases, and low levels of heavy metals are contaminating the area. A magnetometer survey of almost two million square feet of landfill surface identified more than 25 trenches or disposal sites. Some of these trenches are suspected to contain tetraethyllead and other fuel tank bottom sludges, waste acetone contained in steel drums, and low level radioactive wastes. The data indicate contamination gradients extending from the northwest corner of the landfill. The highest number and greatest density of trenches suspected of containing buried steel are also located in the northeast corner of the landfill.

7. There are no written records of pressure tests of the Liquid Fuels System at George AFB. It is reported that there have been no problems with leaks or losses of significant quantities of fuel for the past 20 years. However, failure to protect fuel line low-point drains from corrosive soil conditions is known to have

resulted in the failure of five low-point drains and loss of pressurized fuel. These low-point drains have been replaced and all 21 low-point drains have been corrosion-proofed. There have also been fuel leaks associated with five fuel laterals at the west end of the operational apron. Two lines with faulty hose connectors were replaced. No loss of fuel was suspected or found when the lines were replaced. Three existing lines have been confirmed as leaking and remain out of service. While there have been no indications that these fuel line leaks have contributed to the degradation of environmental quality, these lines are in the immediate vicinity of these sections of the industrial/storm drain which contains oil-enriched sediments and yields high exfiltration rates. The base has no means to monitor deep soils along the pressurized fuel lines for loss of fuels. In the absence of soil gas or other monitoring measures along the length of the pipeline, it is not now feasible to rule out the fuel lines and the known releases of fuel from previously leaking low-point drains and fuel laterals as sources of observed hydrocarbon contamination in the central and northeast disposal areas.

5.0 ALTERNATIVE MEASURES

This section describes the major possible monitoring options, by area and site, for future IRP Phase II efforts at George AFB. The proposed field programs, monitoring plans, and sampling and analytical methodologies are discussed. A second stage Phase II investigation is recommended because the results of the IRP Phase II, Stage 1 monitoring program indicate that organic and heavy metal contaminants are present in all areas of the base that were investigated. However, the data do not at this time provide sufficient information about the contaminant types, their distribution, or sources to enable the Air Force to prepare responsive remedial plans.

5.1 INDUSTRIAL/STORM DRAIN AND OUTFALL DITCH (SITE S-20)

Stage 1 investigations confirm that the outfall ditch soils at a depth of 5 to 10 feet below the ground surface are enriched with chromium, oils and greases. However, the length of the collector sewer and drainage ditch, combined with the history of industrial waste discharges and known accidental fuel spills, precludes accurate determination of sources and potential remedial measures. Shortcomings in the existing data base necessary to make these determinations include:

- All sampling results need replication to confirm the presence of contaminant type and location.
- Industrial/storm drain exfiltration at large rates of water loss have been established but no monitoring of waste stream or sewer line bedding has been accomplished to indicate if contamination is historical or ongoing.
- All outfall ditch samples have been taken at or downstream of known or suspected fuel or industrial/storm water discharges. No sampling efforts have been undertaken to determine background soil chemical properties.

The following monitoring options have been developed for use in collecting the necessary information on which to base future IRP work.

5.1.1 Option 1 - Resample Existing Monitoring Stations

Reoccupation of the seven outfall ditch stations and collection of soil samples for repeat chemical analyses will help to confirm the types and extent of contaminants present. Oil and grease analyses by the IR methodology should not be repeated, however. The technique is useful in a reconnaissance survey to determine the gross presence of probable hydrocarbon contamination. However, the data are a measure of infrared absorbence of the carbon-hydrogen bonds present in the sample matrix and do not differentiate between contaminants of concern or simple organic matter. It is therefore recommended that Stage II analyses include the determination of aromatic and aliphatic hydrocarbons using the gas chromatography with flame ionization detector (GC/FID) or gas chromatography and mass spectrometer (GC/MS) methods.

Chromium, lead, silver, and zinc heavy metal concentrations should also be quantified. Zinc is added to the existing list of heavy metals because of its ubiquity in plating and metals finishing products. It is also recommended that two core tubes be driven into silts and sediments trapped above the small dam in the outfall ditch located near the abandoned percolation ponds. These cores should be driven to resistance or to a maximum of six feet. The cores should be extruded and visually examined for organic enriched layering. Four samples from each core shall be selected and analyzed for the same parameters as those in the reoccupied outfall ditch samples. Once the organic and inorganic chemical species are identified and their concentrations known, the degree of toxicity and persistence in the environment can be evaluated.

The limitations of performing this alternative solely would be that the sources of contamination are not delineated. Suspected chemical gradients indicate that at least storm drain outfalls across from the abandoned percolation ponds are influencing outfall drain soil chemistry. This and other suspicions cannot be confirmed without additional monitoring of potential sources.

5.1.2 Option 2 - Industrial/Storm Drain Monitoring

High rates of exfiltration have been confirmed along several thousand feet of perforated pipe beneath the operational apron. Apparent inaccessibility to the storm drain itself or the soils adjacent to the line caused by the massive

concrete apron has heretofore slowed attempts to monitor soil or groundwater conditions beneath the apron. Collection and chemical characterization of sludges which have accumulated in the storm drain invert, and of drain line bedding and adjacent soils, will help define ongoing industrial discharges and determine the extent of contamination from past activities.

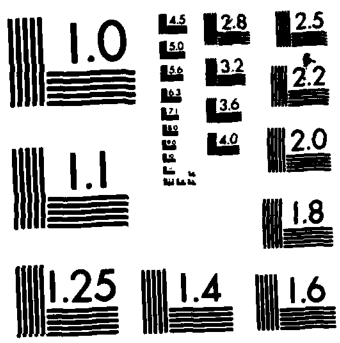
Six borings of not less than 30 feet deep should be drilled by hollow stem auger along the length of the industrial/storm drain. In addition, three borings using cable tool drilling techniques should be made to 30-feet below the groundwater table (or approximately 160 feet below ground surface) and groundwater monitoring wells placed therein. Figure 18 places four of the 30-foot borings and two of the 160-foot borings along the industrial/storm drain tested for exfiltration and known to previously have received direct discharges of industrial wastes. Two 30-foot borings and one 160-foot boring are also recommended along the storm drain line serving aircraft operations at the west end of the operational apron. All storm water runoff from these latter facilities flows north and around the west end of the apron before flowing to the northeast outfall ditch through the gravity storm drain that parallels the crosswind Runway 21.. The second chemical gradient observed in the outfall ditch (see Section 4.4) is likely a consequence of aircraft operations and maintenance activities at the west end of the apron.

Borings should be made through the asphalt drive paralleling the operational apron, or in nearby open spaces where available (e.g., grassy area by the Fire Department washrack). All borings should be made as close as possible to the buried drain lines. No less than two of the borings shall be positioned between Manholes #182 and #186, Section B-C of the exfiltration study.

Six soil samples should be obtained at five-foot intervals in each 30-foot borehole using a split spoon sampler, placed in clean glass jars, and either frozen or kept on ice prior to analysis. A sample volume of not less than 800 ml is recommended. Twelve additional samples of 2,000 ml each should be taken of sediments and sludges in the storm drains or attendant manholes. Six of these samples shall be taken in the industrial drain on the east side of the apron, and five samples collected in the west storm drain. Finally, three samples should be collected from sediments in the standing water located in

AD-A159 727 INSTALLATION RESTORATION PROGRAM PHASE II CONFIRMATION/QUANTIFICATION STA (U) SCIENCE APPLICATIONS INTERNATIONAL CORP BELLEVE WA 2/3

UNCLASSIFIED R W GREILING ET AL 30 AUG 85 SAIC-85/1790 F/G 13/2 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

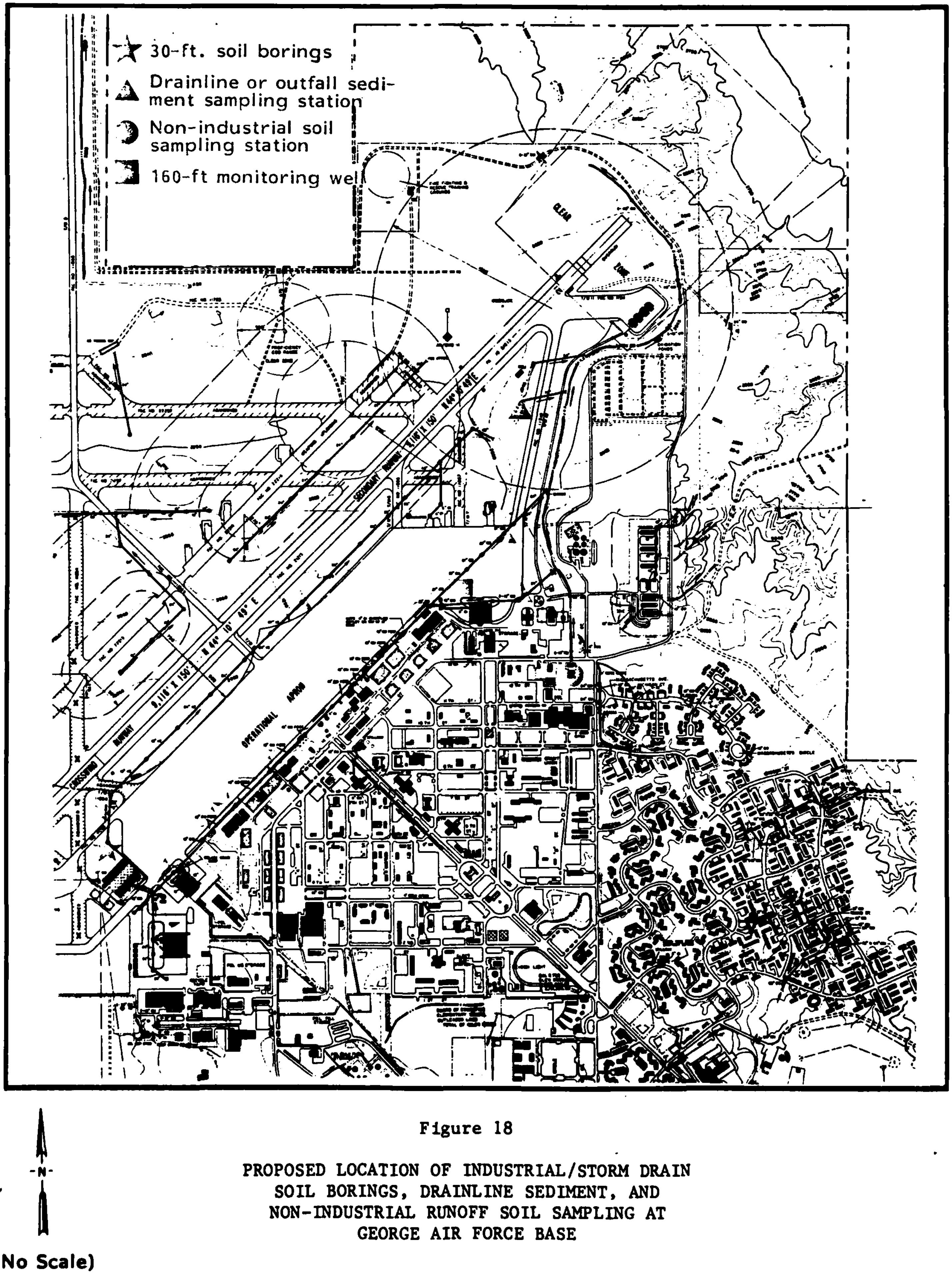


Figure 18

PROPOSED LOCATION OF INDUSTRIAL/STORM DRAIN SOIL BORINGS, DRAINLINE SEDIMENT, AND NON-INDUSTRIAL RUNOFF SOIL SAMPLING AT GEORGE AIR FORCE BASE

the grassy depression between Runway 21 and Taxiway 10 from out of which water discharges to the main outfall ditch.

All 160-foot borings shall be completed with installation of a four-inch I.D. monitoring well with approximately 30 feet of slotted screen. The screen zone shall be sand-packed. Upon completion of sampling at the 30-foot interval, a two-inch I.D. slotted PVC pipe shall be placed in the borehole for long-term monitoring of soil gases. The four borings along the south side of the operational apron will also serve to detect fuel leaks in the hydrant supply lines (see Section 5.6, Fuels Supply). Twenty-five feet of slotted pipe shall be topped with five feet of blank PVC pipe. A threaded end plug shall be fitted on the blank pipe. The top of the PVC pipe shall be protected by a vault and cover installed at grade elevation and capable of withstanding the weight of motorized vehicles present in the area.

All soil borings from the 5-, 10-, and 20-foot intervals (18 total) should be analyzed for aromatic and aliphatic hydrocarbons using gas chromatography with flame ionization detection (GC/FID), volatile organics to determine chlorinated organic contaminant types, and four heavy metals: chromium, lead, silver, and zinc. Approximately 20 percent of these samples should undergo analysis by gas chromatography/mass spectrometry (GC/MS) to confirm fractionation and separation peaks. The remaining 18 borehole samples should be frozen and archived, and only analyzed as necessary (but within 120 days) to define the contaminant gradients and vertical extent of contamination. All 12 drain line or surface sediment samples shall be analyzed using GC/MS methods in order to identify the base neutral organics (particularly the aromatic and aliphatic hydrocarbons), acid extractable organics, and volatile organics. Atomic adsorption spectrometry should be used to determine the presence of heavy metals (Cr, Pb, Ag, and Zn). All groundwater sampled in the four-inch wells should be analyzed for volatile organic chemicals (using EPA Methods 601 and 602) phenols, TOC, and the four heavy metals identified above.

The resultant physical and chemical data will be used to establish the types and extent of contamination in the industrial/storm drain line service area, and to identify contaminant loadings to the industrial outfall ditch. The

data will allow for development of vertical and horizontal contaminant gradients, identify those sections of drain lines most impacted by historical or current waste disposal practices, and identify the extent of contamination if found in the pipeline bedding material or deeper soils beneath the drain line and operational apron.

5.1.3 Option 3 - Nonindustrial Storm Drain Monitoring

The presence of contamination in the outfall ditch above the points of discharge from any of four outfalls serving the operational apron suggests that oil and grease and heavy metal contamination may be nonpoint in origin or from a source not abutting the operational apron. It is recommended that five sampling stations be established (see Figure 18). Two of these stations are in the base housing area and at the end of the concrete storm water drainage ditches. Two stations are at the head of the outfall ditch and upgradient of existing Station ID01. The last station is on 13th Street near the corner of "E" Street and in the vicinity of the fuel truck accidental spill or in the path of its overland flow to the drainage ditch.

All samples shall be collected at two feet and five feet below the ground surface using a hand held or truck mounted auger. The soil materials shall be composited to create a combined sample volume not less than 800 ml. The five samples should be analyzed for aromatic and aliphatic hydrocarbons using GC/FID methods, and heavy metals (Cr, Pb, Ag, and Zn). These data will help to establish the upstream boundary of outfall ditch soil contamination and will help determine if the historical fuel spill is a causal or contributing factor to the contamination observed at Station ID01.

5.2 NORTHEAST DISPOSAL AREA

Contamination of soils and groundwater as measured by oil and grease, halogenated hydrocarbons, and heavy metals is suspected in the spatially broad northeast area of George AFB. More than 20 disposal sites are known to occupy the area. Ten of the sites were HARM ranked. All of the HARM ranked sites but the current fire training area (Site S-5) were included in the IRP Phase II, Stage 1 investigations. Available hydrogeologic and soil and groundwater

chemistry data are inadequate to substantiate the indicated presence of contamination, identify with reasonable certainty possible sources of pollutants, or to identify and evaluate potential remedial alternatives. Information needed to complete the Phase II confirmation investigation include:

- All groundwater sampling results need replication to confirm the presence or absence of a chemical contaminant and, if present, its concentration;
- Determination of soluble versus total heavy metals. Existing data may be influenced by presence of suspended particulates;
- Confirmation of groundwater flow rates and direction;
- Characterization of wastes disposed on or near the ground surface suspected or known to contain contaminants of concern;
- Operation and environmental impacts associated with current fire training activities at Site S-5;
- Hydraulic connection (if any) between industrial/storm drain (Site S-20) and other northeast disposal area sites.

The following monitoring options have been developed to obtain information needed on which to base future IRP work. The areas of these investigations are shown on Figure 19.

5.2.1 Option 1 - Resample Existing Monitoring Stations and County Service Area No. 42

Reoccupation of the six existing monitoring wells in the northeast disposal area will help confirm the type and concentrations of contaminants present. All wells--NZ01 through NZ05, and MW-1--should be sounded and sampled on no less than three occasions. In addition, water supply wells owned by the San Bernardino County Service Area No. 42 in Oro Grande, downgradient but across the Majave River from George AFB, should also be monitored for contaminants of concern. Sampling should include groundwater pH, temperature, and specific conductance. All water samples should be analyzed for volatile organics using EPA Methods 601 and 602 to identify and quantify all volatile organics, including those not currently listed as a priority pollutant (e.g., isomers of xylene). Additional analyses for phenols, TOC, and base neutral organics (principally the aromatic hydrocarbons) should be performed. Heavy metal analyses should be conducted on filtered groundwater samples to determine the dissolved concentrations of Cr, Pb, and Ag.

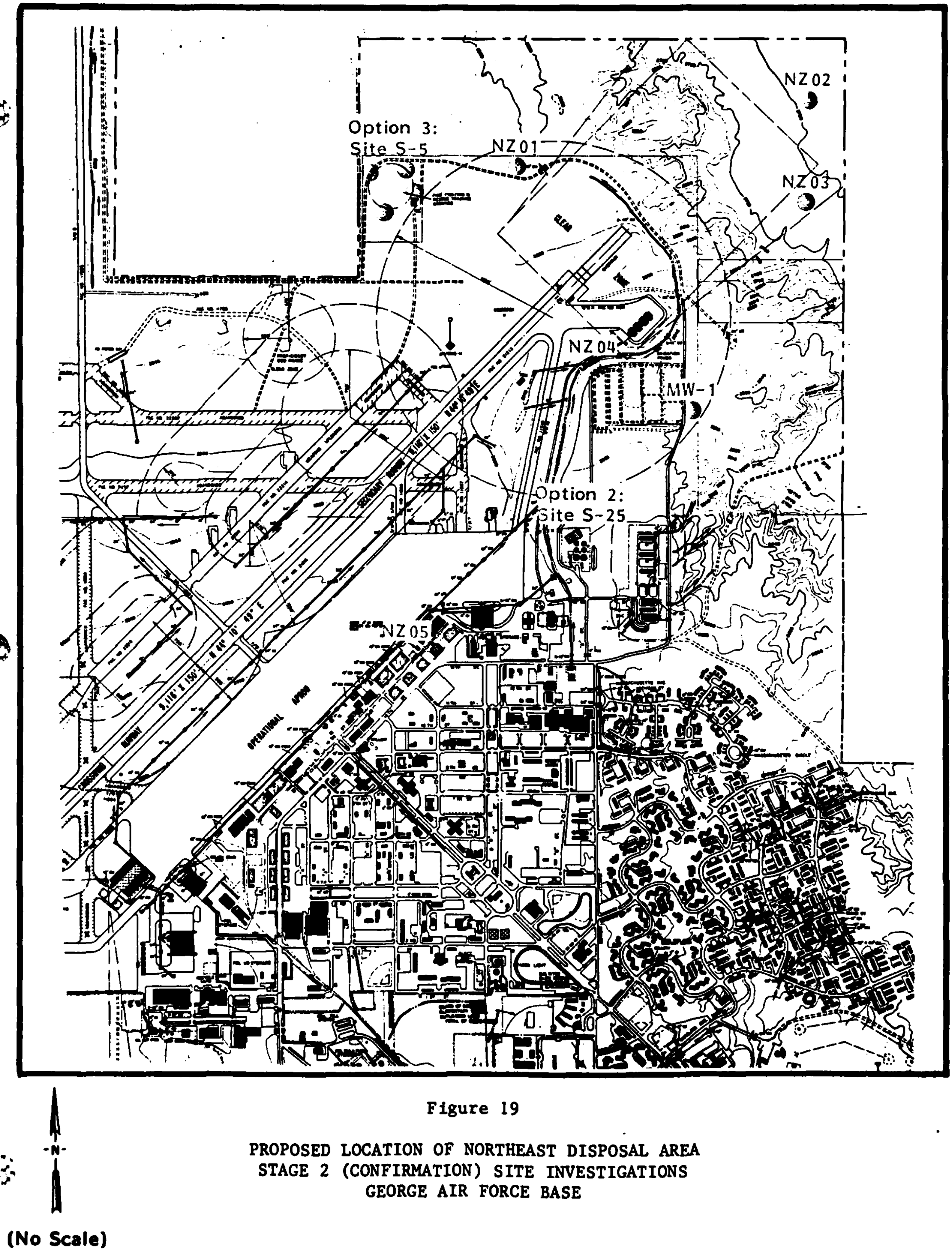


Figure 19

PROPOSED LOCATION OF NORTHEAST DISPOSAL AREA
STAGE 2 (CONFIRMATION) SITE INVESTIGATIONS
GEORGE AIR FORCE BASE

All groundwater samples should also be analyzed for eight inorganic ions including the alkalies (Na and K), alkaline earths (Ca and Mg), alkalinity (CO_3 and HCO_3), and salinity (SO_4 and Cl). These data will be used to perform trilinear diagram analysis of groundwaters in the northeast region in an effort to explain differences in groundwater temperatures and specific conductance.

5.2.2 Option 2 - Sludge Drying Bed Sediment Sampling (Site S-25)

Three one-foot cores should be taken in each of the old sludge beds. The three cores shall then be composited in the laboratory and the composite sample analyzed for heavy metal (Ag, Cr, Cu, Ni, Pb, Zn) contamination of the underlying bedding or soils. The heavy metals of copper, nickel, and zinc are added because of their ubiquity in the work environment and possible impacts to groundwater resources. These same composite samples, one for each drying bed, should be solvent extracted and chracterized for base neutral organics.

5.2.3 Option 3 - Fire Training Area (Site S-5)

A review of construction records should be made to determine the presence and adequacy of the fire fighting pit liner and protective berms. Four soil borings around the site perimeter should be drilled to a depth of thirty feet. Soil samples, collected every five feet, should be analyzed using a portable OVA meter to determine the presence of hydrocarbon contamination. If contamination is detected at depth, the borings should be drilled to not less than 30 feet below the groundwater table and a monitoring well installed. Groundwater levels shall be measured in all wells to be installed, and groundwater should be sampled at least three times and analyzed for pH, temperature, specific conductance, total phenols, volatile and base neutral organics, and dissolved heavy metals (Cr, Pb, Ag, and Zn).

The data from all northeast disposal area monitoring activities should be coupled with the results of additional study activities along the operational apron and Site S-20 industrial outfall ditch. The entire data set will help define groundwater flow direction and rates, the presence of confirmed contamination, more specificity as to the probable pollutant sources, and potential feasible remedial actions.

5.3 SOUTHEAST DISPOSAL AREA

More than 40 disposal trenches or fill sites containing metal wastes or containers were identified in the landfills near the southeast corner of the base. Several of the magnetically responsive disposal trenches are in the northwest corner of the landfill area and are likely sites reported to contain small arms residues and oils (Site M-2), tetraethyllead and other fuel tank bottom sludges (Site L-2), and low-level radioactive wastes (Site L-3). Groundwater monitoring wells indicate that chlorinated hydrocarbons and heavy metal contaminants (Cr and Pb) may be mobilizing and migrating from the west end of the ravine downgradient in a northeasterly direction. Prior to removing these sites from areas of concern, or before initiating remedial actions, the USAF must first:

- Quantify and confirm the presence of heavy metal and organic contamination in all groundwater monitoring wells;
- Analytically characterize organic contaminants in groundwater;
- Investigate suspected burial sites for presence of drummed liquid organic wastes.

5.3.1 Option 1 - Resample Existing Monitoring Wells

Each of the four groundwater monitoring wells should be reoccupied three times to determine depths to the water table, and groundwater pH, temperature, and specific conductance. Water samples should be taken at each occupation and analyzed for volatile organics using EPA Methods 601 and 602, for dissolved heavy metals (Cr, Pb, Ag, and Zn), total phenols, and total organic carbon. In addition, water samples should also be analyzed for gross alpha, gross beta, gross gamma radiation, and elemental uranium since Site L-3 has been identified as a radioactive waste disposal site.

5.3.2 Option 2 - Remote Sensing of Waste Burial Site

Ground penetrating radar (GPR) should be employed in areas of suspected buried metallic wastes to determine the depths to the metal source, and help define its size and shape. GPR has been shown capable of detecting steel drums buried in landfills and other unconsolidated materials.

The application of GPR to the southeast landfills should be accomplished by level of priority in those sites determined by the magnetometer survey to contain large metallic matter of some form. The areas of priority for the GPR investigations are shown on Figure 20 and include:

Level I: Three aréas in the southeast corner of the landfill should be surveyed by GPR prior to other potential areas because the IRP Phase I records search sites a report that more than 120 drums of acetone wastes were buried therein. Total area of the three survey sections is approximately 100,000 square feet. Whether or not the suspected drums of acetone are found in this area, the GPR survey should be extended to the Level II areas.

Level II: Two general areas in the northwest corner of the landfills contain at least 17 trenches of wastes and are believed to be Sites L-2, L-3, and M-2. The GPR surveys should be accomplished across the width of the low swale leading into the landfill area from the west access road and across the entirety of the small ravine to the north of the posted radioactive disposal signs. Total area of the two survey sections is approximately 125,000 square feet. If the drums suspected of containing acetone have been identified in the areas of Level I or II priority, it is recommended that GPR studies not proceed into Level III areas.

Level III: Six areas in the mid-section of the main landfill (Site L-1) lie close to the main access road or spur roads within the sites. Burial trenches are frequently noticeable from the ground surface. The orientation of the trenches and their position in the latter stages of the landfill suggest they are younger in age than other portions of the landfill and were likely filled in the 1960s. Total area of the six sections is approximately 250,000 square feet.

5.3.3 Option 3 - New Well Placement in Southeast Corner of Landfills

If GPR Level I surveys suggest the presence of drummed wastes in one or more of the eight trenches shown to contain significant quantities of metal, or if Well SZ02 shows contamination by chlorinated solvents, two wells should be drilled northeast of the eastern edge of the landfills (see Figure 20). These wells should be drilled to at least 30 feet below the water table. Sediment and groundwater samples should be analyzed for volatile chlorinated organics, dissolved heavy metals, and other analytes as taken in the existing wells.

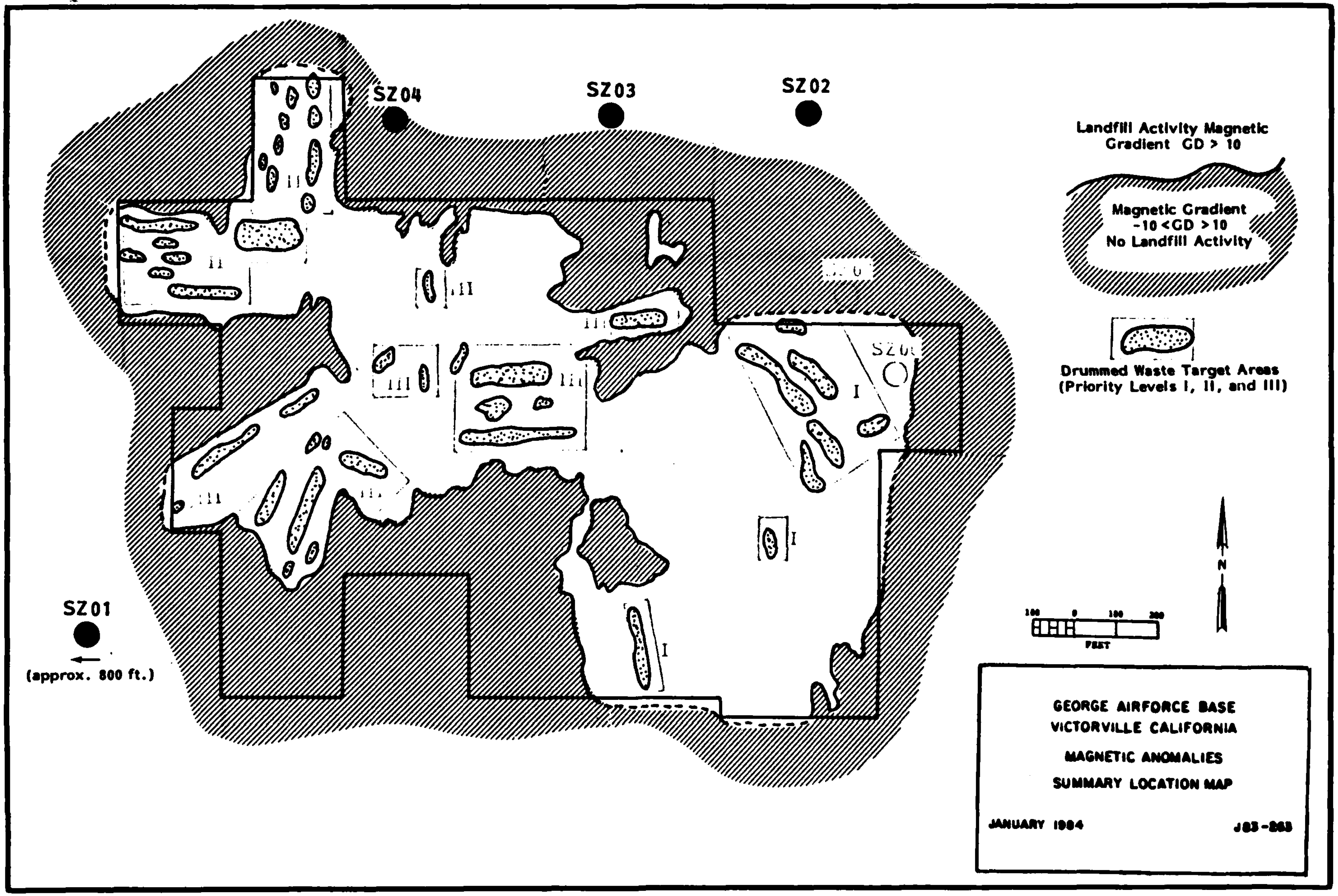


Figure 20

PROPOSED LOCATION OF SOUTHEAST DISPOSAL AREA STAGE 2 (CONFIRMATION) SITE INVESTIGATIONS, GEORGE AIR FORCE BASE

5.4 CENTRAL DISPOSAL AREA

Soil and groundwater chemistry indicate the presence of hydrocarbon contamination. This single well and single sample are insufficient to determine if one or more sources may be the cause of the suspected contamination. Additional data are needed to support the decision making process.

5.4.1 Option 1 - Resample Existing Monitoring Well

Well CZ01 should be sounded and sampled at least three more times. Water quality parameters to be analyzed include pH, temperature, and specific conductance. Filtered water samples shall be analyzed for heavy metal (Cr, Pb, Ag, Zn) content. Water samples shall also be tested for contamination by PCBs, volatile organics, base neutral organics, and total organic carbon.

5.4.2 Option 2 - Shallow Soil Boring Near Waste Fuel Dry Wells

A single 50-foot deep soil boring should be drilled near each of the brick dry wells used for disposal of oil near Building 555 (Site S-22), and disposal of waste jet fuel near Building 559 (Site S-23). Soil samples shall be collected every five feet and analyzed for heavy metals (Cr, Pb, Ag, Zn) and base neutral organics when an OVA meter indicates the presence of volatile hydrocarbons. Confirmed soil contamination shall require continued drilling to 30 feet below the water table, insertion of a PVC casing, and completion of the monitorng wells. Groundwater samples should be collected three times and measured for the same parameters as in Well CZ01.

All CZ01 data need to be interpreted simultaneously with Stage 2 investigation results on Site S-20 work in the industrial/storm drain, and in all site investigations and follow-on monitoring in the northeast disposal area.

5.5 WEST PERIMETER ROAD AREA

There is insufficient evidence to determine if past roadway application of waste fuel has caused contamination. There is also evidence to suggest that the two samples collected may not have been taken from the roadways which received the greatest rates of application.

5.5.1 Option 1 - Resample the West Perimeter Road

Four 6-inch deep soil samples should be collected from the middle of the west perimeter road (see Figure 21). Each sample should be analyzed for aromatic and aliphatic hydrocarbons using either GC/MS or GC/FID methods, heavy metals (Cr, Pb, Ag, Zn) and total organic carbon.

5.5.2 Option 2 - Sample the Interior Access Road to the Jet Engine Test Cell

Four samples shall be collected from the north-south access road leading to the jet engine test cell (see Figure 21). The sampling methodology and analytical schedule are the same as above.

5.6 LIQUID FUELS SUPPLY

No positive safeguards have been installed along the length of the liquid fuels distribution system to ensure that leaks are detected and arrested before environmental impacts or personnel safety are threatened. Corrosive soil conditions have in the past caused low point drains to leak. At least three JP-4 laterals from fuel filter pits at the west end of the operational apron have been proven to have lost fuel when pressurized.

Soil gas monitoring provides a means by which leaking fuels entrained in the alluvium soils can be detected. The installation of slotted well casings in deep boreholes adjacent to tank storage or liquid fuels distribution lines will help provide long-term monitoring of soil gases. Figure 22 presents the proposed locations of 11 borings and slotted PVC casings to be installed near the bulk fuels storage area and along main distribution lines and hydrants. The final placement of these borings should take into consideration the locations of the five low-point drains which were once highly corroded, were found to be leaking fuel into the subsurface soils, and were ultimately replaced. The four borings along the operational apron also serve as soil gas monitoring stations for work along the industrial/storm drain (see Section 5.1).

Soil samples should be collected at five-foot intervals during drilling of the 30-foot boreholes. Any sample indicating fuel contamination as seen by the field geologist or detected by OVA meter should be analyzed for the volatile and base neutral organics. Once the slotted casing is installed, soil gas

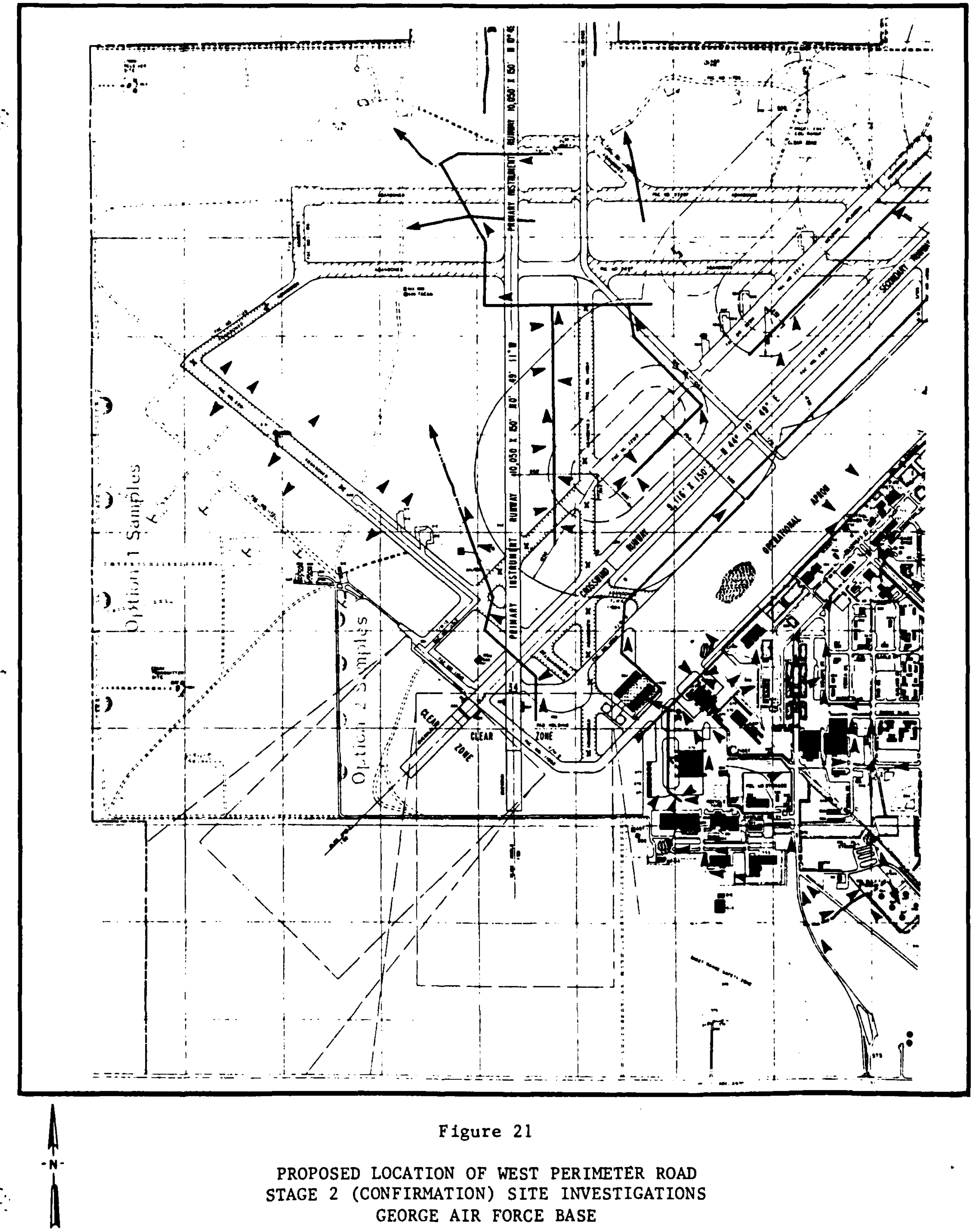


Figure 21

PROPOSED LOCATION OF WEST PERIMETER ROAD
STAGE 2 (CONFIRMATION) SITE INVESTIGATIONS
GEORGE AIR FORCE BASE

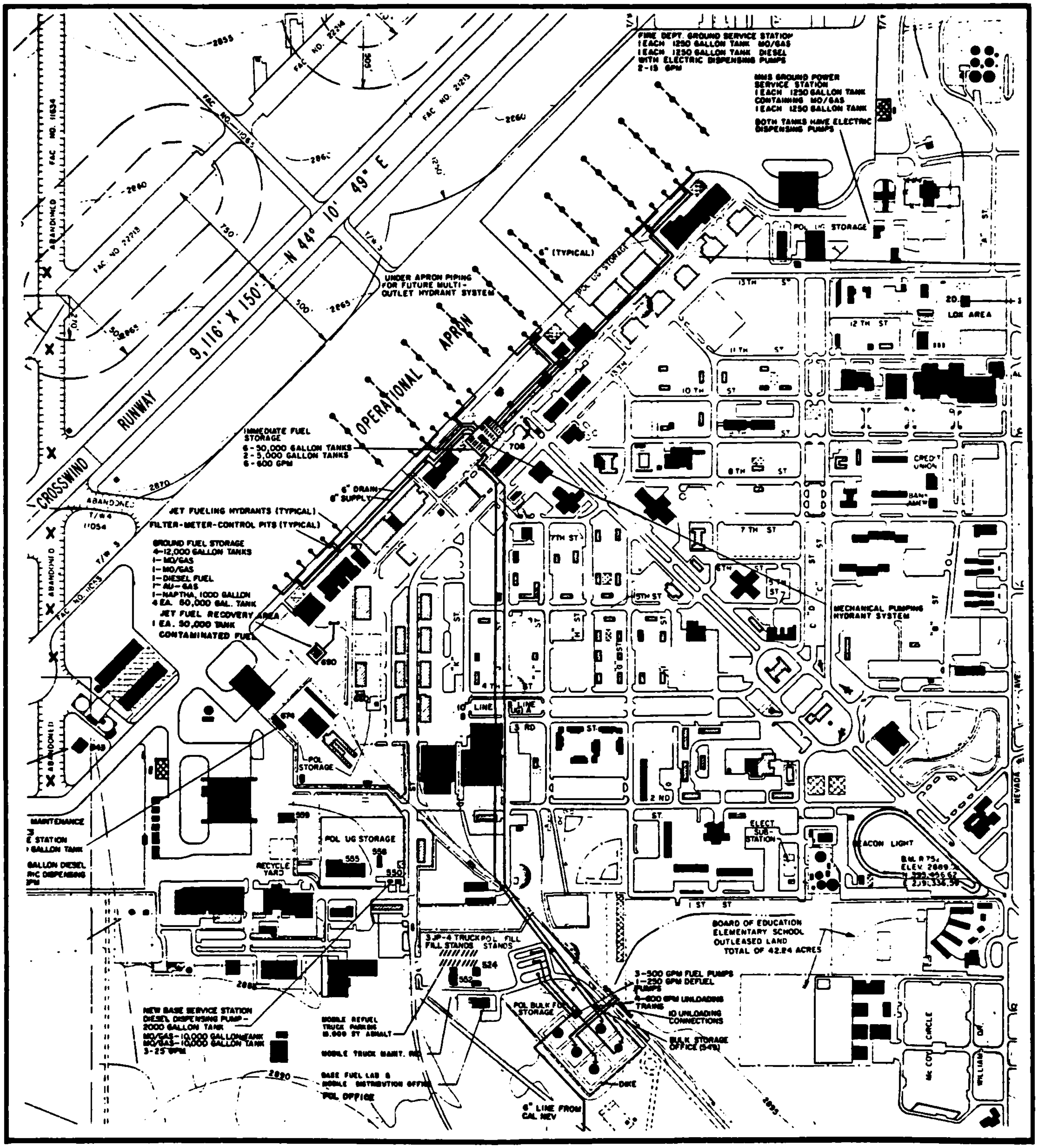


Figure 22

PROPOSED LOCATION OF SHALLOW BORINGS AND CASINGS
FOR FUEL LINE LEAK DETECTION INSTALLED DURING
STAGE 2 (CONFIRMATION) INVESTIGATIONS
GEORGE AIR FORCE BASE

-N-

(No Scale)

analyses should be performed as part of the routine preventive inspection of the fuels distribution system.

5.7 SUMMARY OF POTENTIALLY FEASIBLE ALTERNATIVE MEASURES

A review of all field observations and analytical results was made to determine what actions could be taken to reduce or eliminate contaminant release from known or suspected sources, and to contain or remove contaminants from the environment. While a number of remedial alternatives are available to effect the desired changes, the absence of data replication and true confirmation of contaminant types and quantities precludes final selection of sites or remedial actions until such data are available. Table 13 presents a summary of potential remedial alternatives identified for all the sites surveyed, and identifies the information which must be obtained prior to determining the types of actions to follow.

Table 13

SUMMARY OF ALTERNATIVE MEASURES FOR REMEDIAL PLANNING IN ACCORDANCE WITH THE IRP PROGRAM AT GEORGE AIR FORCE BASE

Area	Site	Problem Description	Potential Remedial Alternatives	Data Gaps
Central	S-19 Transformer Oils S-22 French Drain (dry well) S-23 French Drain (dry well)	• Hydrocarbon contamination of soil and groundwater	• Soil excavation and disposal • Soil aeration • Control of water run-on to dry wells • Removal/closure of dry wells • Long-term monitoring program	• Replication of groundwater sampling data • Soil gas data from Buildings 555 and 559 • Soil chemical characterisitcs near Buildings 555 and 559 • Confirmation of groundwater flow • Soluble heavy metals (Cr, Pb) in groundwater
West Perimeter Road	S-4 Fuel and Oil Disposal	• Hydrocarbon contamination of surface soils	• Road surface aeration • Hot spot excavation and disposal • Surface sealing	• Replication of road surface soils • Road surface oil and grease and heavy metals on interior base road to engine test cell
Southeast	L-1 Base Landfill L-2 TEL Disposal Site L-3 Radioactive Disposal L-4 Munitions Disposal/Starter Cartridges M-2 Small Arms Residue/Oil	• Suspected buried waste liquid solvents • 30 or more waste disposal trenches • Buried tetraethyl lead and other fuel storage tank bottoms • Buried radiological and low-level radioactive wastes • Hydrocarbon contamination of soils and groundwater • Halogenated hydrocarbon gradients below suspected TEL disposal area • Heavy metals in groundwater	• Site closure plan, final covers • Run-on control • Excavation and removal of wastes or most-contaminated soils • Long-term monitoring	• Probable disposal trenches of containerized solvents • Replication of groundwater sampling data • Soluble vs. total heavy metal data • Confirmation of groundwater flow • Soil gas data for TEL site
N/A	S-20 Industrial/Storm Drain and Outfall Ditch	• High rate exfiltration of historical wastes and current storm runoff • Heavily industrialized collection service area • Measurable oil and grease and heavy metal contamination • Concentration gradients indicated below outfall discharges	• Storm drain and manhole cleaning • Confirmed separation of industrial wastes • Soil excavation and removal • Chemical stabilization • Bio-uptake and transformation • Soil aeration • Soil gas monitoring • Long-term monitoring	• Replication of existing sampling data • Chemical characterization of sediments above dam in outfall ditch • Chemical characterization of sludges in drain lines • Chemical enrichment of pipeline bedding and trench soils • Nonpoint street or ditch soil samples upgradient of known contamination in outfall ditch
Northeast	B-8 Pesticide and Paint Burial B-9 Acid and Oil Burial B-10 Pesticide and Oil Burial L-11 Street Sweeping Disposal L-12 Original Base Landfill L-13 Base Landfill S-6 Abandoned Fire Training Area S-21 STP Percolation Ponds S-25 Sludge Drying Beds ALSO	• Measurable TOC, oil and grease, phenol, and halogenated hydrocarbons in soils or groundwater • Heavy metals (Cr,Pb,Ag) in groundwater above EPA criteria levels	• Nondestructive remote sensing of landfill wastes • Site closure plan and new final covers • Control of surface water run-on • Groundwater withdrawal and treatment or disposal • Long-term groundwater monitoring	• Replication of gr[illegible]dwater sampling data • Soluble vs. total [illegible]avy metal data • Confirmation of groundwater flow
	S-5 Fire Training Area	• Waste fuels applied to surface • Proximity to Well NZ01 with confirmed groundwater contamination	• Enhanced liner and containment	• Construction criteria • Soil contamination • Groundwater flow

6.0 RECOMMENDATIONS

Recently completed IRP Phase II, Stage 1 (Confirmation) Investigations have identified areas of George AFB which appear to be contaminated by oils and greases, halogenated hydrocarbons, heavy metals, or combinations of the above. Because all findings are based on results from a single sampling event, they are not conclusive but instead are advisory in nature. The data indicate that one or more areas of contamination exists at George AFB, and that the data set is inadequate to confirm the types and quantities of contamination, the spatial and vertical extent of that contamination, and the temporal significance between historical and ongoing discharge of pollutants. In consideration of the above, continued IRP investigations are recommended. Both site specific and general recommendations are described below. The supporting findings, discussion, and conclusions leading up to these recommendations were presented in Sections 4.0 and 5.0.

6.1 SITE SPECIFIC RECOMMENDATIONS

Each of the five geographic areas previously investigated should be reexamined further. Such investigations range from reoccupation and sampling of existing monitoring wells, to a second level of nondestructive remote sensing in the southeast landfills in continuation of the search for buried waste liquid solvents. Table 14 presents a summary of recommendations for continued field work and analysis of new soil and groundwater samples. Section 5.0 presented the development of data needs and alternatives by which the information could be obtained. The schedule in Table 14 includes many of the optional site specific investigations previously discussed. In some instances, particularly for a number of remote sensing and well construction activities in the southeast landfill area, the proposed field activities are dependent upon the results of early activities in the sequence. A general summary of the overall proposed Stage II activities includes the following activities:

- Twenty-three borings, 52 soil samples (34 analyzed), and 9 water samples in the industrial/storm drain system;
- Twelve samples of storm drain sludges collected and analyzed;

Table 14

RECOMMENDED IRP PHASE II, STAGE 2 (CONFIRMATION) FIELD INVESTIGATION AND ANALYTICAL SCHEDULE FOR GEORGE AFB, CALIFORNIA

Site Identification	Field Activity	Analytical Schedule	Total Elapsed Field and Lab Time
Industrial/Storm Drain and Outfall Ditch (Site S-20)	• 7 soil samples in outfall ditch (2 soil cores, 4 samples, taken from settled silts above dam)	• Aromatic and aliphatic hydrocarbons by GC/MS or GC/FID • Dissolved heavy metals (Cr,Pb,Ag,Zn) • TOC • Phenols • Percent moisture	3 weeks
	• Six 30-ft borings along drain line (36 samples collected; 18 samples analyzed; 6 PVC casings installed)	• Aromatic and aliphatic hydrocarbons by GC/MS or GC/FID • Dissolved heavy metals (Cr,Pb,Ag,Zn) • TOC • Percent moisture	6 weeks (concurrent)
	• Three 160-ft borings and monitoring wells (9 water samples; 3 PVC casings installed)	• Volatile organics (Method 601/602) • Phenols • TOC • Dissolved heavy metals (Cr,Pb,Ag,Zn) • pH • Temperature • Specific conductance	6 weeks (concurrent)
	• 11 drain line sediment/sludge samples • 1 north outfall marsh area sediment	• Base neutral organics • Volatile organics (Method 624) • Acid extractable organics • Dissolved heavy metals (Cr,Pb,Ag,Zn) • TOC • Percent moisture	5 weeks (concurrent)
	• 5 soil samples upgradient of outfall ditch	• Aromatic and aliphatic hydrocarbons by GC/MS or GC/FID • Dissolved heavy metals (Cr,Pb,Ag,Zn)	3 weeks (concurrent)
Northeast Disposal Area (Sites B-8,B-9,B-10,L-11,L-12, L-13,S-6,S-21,S-25)	• Resample 6 monitoring wells on three occasions (18 water samples) • Sound water table	• Volatile organics (Method 601/602) • Base neutral organics • Phenols • TOC • pH • Temperature • Specific conductance • Dissolved heavy metals (Cr,Pb,Ag,Zn) • Alkalies (Na, K) • Alkaline earths (Ca, Mg) • Alkalinity (CO_3, HCO_3) • Salts (SO_4, Cl)	12 weeks
	• 24 sludge drying bed soil cores (8 composite samples)	• Dissolved heavy metals (Ag,Cr,Cu,Ni,Pb,Zn) • Base neutral organics • TOC • Percent moisture	4 weeks (concurrent)
Fire Training Area (Site S-5)	• Four 30-ft borings (24 samples collected; 12 samples analyzed [est.])	• Base neutral organics • Phenols • TOC • Volatile organics • Dissolved heavy metals (Cr,Pb,Ag,Zn) • Percent moisture	Determined by contaminant types in Well NZ01 (est. 5 weeks)
	• Possible installation of monitoring wells and collection of up to 12 water samples • Sound water table	• Volatile organics (Method 601/602) • Base neutral organics • Dissolved heavy metals (Cr,Pb,Ag,Zn) • pH • Temperature • Specific conductance • Phenols • TOC	Determined by above soils investigations (est. 12 weeks)

Table 14
(cont'd)

Southeast Disposal Area (Sites L-1,L-2,L-3,L-4,M2)	• Resample 4 existing monitoring wells on three occasions (12 water samples) • Sound water table	• Base neutral organics • Volatile organics (Method 601/602) • Dissolved heavy metals (Cr,Pb,Ag) • Phenols • TOC • pH • Temperature • Specific conductance • Gross alpha, gross beta, gross gamma, and elemental uranium	12 weeks
	• Ground penetrating radar over Level I sites (8 trenches) and Level II sites (17 trenches)	• None	5 weeks (concurrent)
	• 2 groundwater monitoring wells installed north and/or east of Level I disposal sites • Three groundwater samples from each well (6 water samples) • Sound water table	• Base neutral organics • Volatile organics (Method 601/602) • Dissolved heavy metals (Cr,Pb,Ag,Zn) • Phenols • TOC • pH • Temperature • Specific conductance	Determined by results of Level I GPR Survey (est. 12 weeks)
	• Ground penetrating radar over Level III sites (19 trenches)	• None	Performed only if GPR Suveys in Level I and Level II areas are inclusive (est. 3 weeks)
Central Disposal Area (Sites S-19,S-22,S-23)	• Resample existing well three times (3 water samples) • Sound water table	• Volatile organics (Method 601/602) • Base neutral organics • TOC • PCBs • Dissolved heavy metals (Cr,Pb,Ag,Zn) • pH • Temperature • Specific conductance	12 weeks
	• Two 50-ft shallow borings near dry wells (22 soil samples collected; OVA screening; 6 soil samples analyzed [est.])	• Base neutral organics • TOC • Heavy metals (Cr,Pb,Ag,Zn) • Percent moisture	5 weeks
	• Possible installation of monitoring wells and collection of 6 water samples • Sound water table	• Volatile organics (Method 601/602) • Base neutral organics • TOC • pH • Temperature • Specific conductance • Phenols • Dissolved heavy metals (Cr,Pb,Ag,Zn)	Determined by above soils investigations (est. 12 weeks)
West Perimeter Road (Site S-4)	• Four 6-inch soil samples from the West Perimeter Road	• Aromatic and aliphatic hydrocarbons • Heavy metals (Cr,Pb,Ag,Zn) • TOC • Percent moisture	4 weeks
	• Four 6-inch soil samples from the Test Cell access road	• Aromatic and aliphatic hydrocarbons • Heavy metals (Cr,Pb,Ag,Zn) • TOC • Percent moisture	4 weeks (concurrent)
Liquid Fuels Supply	• Eleven 30-ft boreholes along pipeline right-of-way (4 borings part of Site S-20 investigations; Install PVC casings for soil gas monitoring capability; 49 soil samples; 7 soil samples analyzed [est.])	• Aromatic and aliphatic hydrocarbons • Heavy metals (Cr,Pb,Ag,Zn) • TOC • Phenols • Percent moisture	6 weeks

- Thirteen borings and PVC screens placed for soil gas monitoring near the liquid fuels distribution lines and industrial/storm drain;

- Resampling of 11 existing groundwater monitoring wells (33 samples) for measurement of hydrocarbons, metals, and conventional parameters;

- Borings, soil chemistry, and possible monitoring wells near the fire training area, in the old treatment plant sludge drying beds, and near the waste oil and waste fuel dry well disposal sites;

- Ground penetrating radar across 25 trenches in the southeast landfills and possible surveys across an additional 19 trenches.

6.2 GENERAL RECOMMENDATIONS

Prior to and/or following any Stage 2 (Confirmation) Investigations, the Air Force should adopt a long-term monitoring program and implement additional best management practices to prevent the release of potentially harmful contaminants to the environment. It is recommended that:

1. An interim monitoring program be established using the monitoring wells established during this and any subsequent investigations. The purpose of this monitoring program is to measure and record water quality and detect temporal changes which may provide advance indications of changes in rates of leachate migration or other chemical characteristics. Table 15 presents a recommended sampling program which can be carried out by base personnel with minimal demands on time or equipment. Selected Phase II monitoring wells and base water supply wells should be sampled four times per year, including the season of highest precipitation (i.e., perhaps March to May), to monitor potential leachate migration and contaminant release into groundwaters. The frequency of sampling and the analytical schedule should be evaluated at the end of the first year.

   Prior to each sampling event the wells should be bailed to remove three or more casing volumes. For the given wells, this equates to approximately 6 to 8 gallons of water per well. Once the well has been bailed, the water sample can be taken at a single depth in the water column or a composite sample can be made of equal volumes taken at multiple discrete depths. Field experience has demonstrated that all wells can be flushed and sampled in approximately eight hours. The chemical analyses can be performed locally or the samples can be packaged and shipped to USAF laboratories. It is recommended that data be plotted on graphs for visual detection of trends, that running averages be calculated, and that the total data set be periodically examined. Groundwater chemical characterizations can be compared against current and proposed EPA drinking water standards as a first test for the presence of chemical contamination (refer to Table 9).

Table 15

RECOMMENDED INTERIM MONITORING PROGRAM FOR GEORGE AIR FORCE BASE

Well Classification	Frequency	Well ID	Parameters in Each Well Tested
Class I			
Wells selected on the basis of their location down-gradient of industrial activities or waste disposal/spill sites.	4 per year (first year), reassess sampling interval and analytical schedule at Year 2	NZ01 NZ02 NZ03 NZ04 NZ05 SZ02 SZ04	pH Temperature Specific Conductance Total Organic Carbon (TOC) Phenols Purgeable halocarbons Purgeable aromatics Dissolved Metals (Cr,Pb,Ag,Zn)
Class II			
Wells to be tested to confirm presence of contaminants in Class I wells or for QA/QC confirmation.	As Needed	CZ01 SZ01 SZ03 MW-1	As Needed

NOTE: All wells should be flushed at least once every six months, or as necessary to prevent silt accumulation and solidification. Whenever wells are to be abandoned, they should be sealed and closed in accordance with the State of California Water Well Standards, Bulletin 74-81, Section 23, "Requirements for Destroying Wells" (1981).

The wells should be resampled and the same analyses replicated whenever it appears an increased release of contaminants may have occurred. If the replicated sets confirm the previous findings, follow-on investigations should begin to determine the source(s) of chemical contamination.

2. Accessible manholes along the industrial/storm drain line beneath the operational apron should be inspected at least twice per year for accumulation of silts. Oil-saturated silts should be removed regularly from manholes and the drain line.

3. It is recommended that the Liquid Fuels Shop maintain written records of pressure test data for the liquid fuel system. The task of pressure testing the system should be accomplished in pipe lengths not exceeding 1,000 feet in length on lines of 8-inch diameter or larger (approximate volumes of 2,600 and 4,100 gallons in the 8-inch and 10-inch lines at George AFB). Tested line lengths should not exceed 2,000 feet for any other pipe diameter. Holding the length of line tested at any one time to the above limits will reduce the potential fuel loss during such tests. Any suspected or known leaks or significant corrosion should be recorded and immediately repaired. Finally, a copy of fuel line inspections, tests, and reported leaks should be forwarded to the Base Environmental Engineer.

APPENDICES

Appendix A - References

Appendix B - Glossary of Terms and Acronyms

Appendix C - Scope of Work

Appendix D - Well Logs and Well Construction Summaries

Appendix E - Magnetic Survey Gradient Plots

Appendix F - Chemistry Data

Appendix G - Exfiltration Data Tables and Plots

Appendix H - California Lambert Coordinate System

Appendix I - QA/QC/Chain of Custody

Appendix J - Safety Plan

Appendix K - Biosketches of Key Personnel

NOTE: JRB Associates (JRB) as used here and elsewhere was the former name of the environmental division of Science Applications International Corporation (SAIC). All references to JRB Associates should be considered as references to Science Applications International Corporation.

APPENDIX A

REFERENCES

REFERENCES

American Public Health Association, American Water Works Association, Water Pollution Control Federation, 1981. Standard Methods for the Examination of Water and Wastewater, Washington, D.C.

Bates, Robert L. and Julia A. Jackson, 1980. Glossary of Geology. American Geological Institute, Falls Church, Virginia.

California Department of Corrections, 1983. Adelanto Prison Water Supply Alternatives Study. Metcalf and Eddy, San Bernardino, California.

California Department of Water Resources, 1967. Mojave River Groundwater Basins Investigations. Bulletin No. 84.

Calfiornia Department of Water Resources, 1981. Standards: State of California. Bulletin 74-81.

CH2M Hill, 1982. Installation Restoration Program Records Search for George Air Force Base, California.

Compton, Robert R., 1962. Manual of Field Geology. John Wiley and Sons, Inc., New York.

Cook, R. J., J. C. Barron, R. I. Papendick, G. J. Williams III, 1981. Impact on Agriculture of the Mount St. Helen's Eruptions. Science, Vol. 211 pp. 16-21.

Davis, Stanley M. and Roger J. M. DeWeist, 1966. Hydrogeology. John Wiley and Sons, New York.

Dietrich, R.V., J.T. Dutro Jr. and R.M. Foose, 1982. American Geological Institute Data Sheets. American Geological Institute, Falls Church, Virginia.

EPA National Secondary Drinking Water Regulations. 44FR42198. Effective January 19, 1981.

Everett, Lorne G., 1980. Groundwater Monitoring. General Electric Company, New York.

Hach Company, 1984. Chemical Procedures Explained. Loveland, Colorado.

Hurlburt, Cornelius S. and Cornelius Klein, 1977. Manual of Minerology. John Wiley and Sons., New York.

Moffitt, Francis H. and Harry Bouchard, 1975. Surveying. Sixth Edition, Harper and Row, Publishers, New York.

Reading H.G., 1978. Sedimentary Environments and Facies. Elsevier Press, New York.

APPENDIX B

GLOSSARY OF TERMS AND ACRONYMS

GLOSSARY OF TERMS AND ACRONYMS

Alluvial - Deposited by a stream or running water.

Alluvium - A general term for clay, silt, sand, gravel or similar unconsolidated detrital material deposited during comparatively recent geologic time by a stream or other body of running water.

Annulus - The space between the casing in a well and the wall of the hole, or between the drill string and the wall of the hole.

Aquifer - A formation that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs.

Bentonite - A commercial term applied to any of numerous clay deposits containing montmorillonite as the essential mineral and used chiefly to thicken drilling muds or form a grout based on its ability to swell in water.

BMP - Best Management Practice.

Contamination - The degradation of soil chemistry or natural water quality to the extent that its usefullness is impaired. There is no implication of any specific limits to water quality since the degree of permissible contamination depends upon the intended end use or uses of the water.

DDT - Dichlorodiphenyltrichloroethane (a pesticide).

DEQPPM 81-5 - Defense Environmental Quality Program Policy Memorandum 81-5.

Dipole (magnet) - Two poles of opposite charge with an infintesimal field; a pair of equal and opposite charges or magnetic poles.

Disposal Facility - A facility or part of a facility at which hazardous waste is intentionally placed into or on land or water, and at a location at which the waste will remain after closure.

Disposal of Hazardous Waste - The discharge, deposit, injection, dumping, spilling or placing of any hazardous waste into or on land or water so that such waste or any constituent thereof may enter the environment or be emitted into the air or discharged into any waters, including groundwater.

DoD - (United States) Department of Defense.

DPDO - Defense Property Disposal Office, previously included Redistribution and Marketing (R&M) and Salvage.

Drilling Mud - A heavy suspension usually in water used in well drilling. It commonly consists of bentonitic clays and barite and is pumped continuously down the drill pipe forcing it back up the annulus for lubrication and blowout or cave-in prevention.

Drill String - A term used in well drilling for the assemblage in a borehole of stem, pipe, collars and bits, respectively.

Dump - An uncovered land disposal site where solid and/or liquid wastes are deposited with little or no regard for pollution control or aesthetics. Dumps are susceptible to open burning and are exposed to the elements, disease vectors and scavengers.

Effluent - A liquid waste discharged in its natural state from a manufacturing or treatment process. Such waste shall be partially or completely treated.

EPA - (United States) Environmental Protection Agency, or one of 10 regional offices.

ERG - Environmental Research Group, a contract laboratory to SAIC.

Erosion - The wearing away of land surface by water or chemical, wind or other physical processes.

Exfiltration - A filtering out; a gradual escape through a wall or a membrane, a leak.

Facility - Any land and appurtenances thereon which are used for the treatment, storage and/or disposal of hazardous wastes.

Flow Path - The direction or movement of groundwater as governed principally by the hydraulic gradient.

Fluvial - Of or pertaining to a stream or river; produced or deposited by a stream or river.

Formation - A persistent body of igneous, sedimentary, or metamorphic rock having easily recognizable boundaries that can be identified in the field.

Gauss - A unit of measure for magnetic induction (flux density), with the magnetic field conventionally symbolized as B. The magnetic field 1 cm from a straight wire carrying 5 amps is one gauss.

Gradient - The degree of inclination or the rate of ascent or descent of a feature such as a stream channel or land surface structure.

Groundwater - Water beneath the land surface in the saturated zone that is under atmospheric or artesian pressure.

HARM - Hazard Assessment Rating Methodology.

Hazardous Waste - A solid waste or combination of solid wastes, which because of its quantity, concentration, or physical, chemical or infectious characteristics may cause or significantly contribute to an increase in mortality or an increase in serious, irreversible, or incapacitating reversible illness; or pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed.

Hydrology - The science that deals with the occurrence, circulation, distribution, and properties of water of the earth and the earth's atmosphere.

I.D. - Inside Diameter

Indurated - Describes a rock or soil hardened or consolidated by pressure, heat, or cementation.

IRP - Installation Restoration Program.

JRB - JRB Associates, formerly a division of Science Applications International Corporation, and the name of the division when this IRP project was inititated.

Lacustrine - Pertaining to, produced by, or formed in a lake or lakes.

Leachate - A solution resulting from the separation or dissolving or soluble or particulate constituents from soild waste or other man-placed medium by percolation of water.

Leaching - The process by which soluble materials in the soil, such as nutrients, pesticide chemicals or contaminants, are washed into a lower layer of soil or are dissolved and carried away by water.

Low-Point Drain - A component of a fuel system which is used to drain condensate and particulate accumulations at a low point in the system.

Magnetometer - An instrument that measures the earth's magnetic field and its changes.

Magnetosphere - The confines of the earth's magnetic field due to interaction between the solar wind and the geomagnetic field.

MCL - Maximum Contaminant Limit.

mg/kg - Milligrams per kilogram, a mass to mass ratio in parts per million (ppm).

mg/l - Milligrams per liter, a mass to liquid ratio in parts per million (ppm).

ug/l - Micrograms per liter, a mass to liquid ratio in parts per billion (ppb).

Monitoring Well - A well used to measure groundwater levels and to obtain samples.

MSL - Mean Sea Level.

OEHL - Occupational and Environmental Health Laboratory (USAF) at Brooks AFB, Texas.

Oersted - A unit of measure for magnetic field intensity or magnetic force with an induction B (magnetic field) induction of one gauss.

Organic - Being, containing, or relating to carbon compounds, especially in which hydrogen is attached to carbon.

PCB - Polychlorinated biphenyl, a group of chlorinated phenolic compounds both highly toxic and persistent.

Permeability - The property or capacity of a porous rock, sediment, or soil for transmitting a fluid.

Playa - A term used in the southwestern United States for a dry, vegetation-free, flat area at the lowest part of an undrained desert basin, underlain by stratified clay, silt or sand, and commonly by soluble salts.

Pleistocene - The latest period of time in the stratigraphic column. An epoch of the Quaternary period which began two th three million years ago.

POL - Petroleum, Oils and Lubricants.

Pollutant - Any gas, liquid or solid introduced into the environment that alters and contaminates it and makes it unfit for a particular use.

Porosity - The measure of the bulk volume of a rock or soil that is occupied by void spaces, whether isolated or connected.

Precession - A comparatively slow gyration of the rotation axis of a spinning body about another line intersecting it so as to describe a cone caused by the application of torque tending to change the rotation axis.

PVC - Polyvinyl chloride (a plastic).

Quarternary Deposits - A system of rocks and strata deposited during the second period of the Cenozoic era. It began three million years ago and extends to the present.

RCRA - Resource Conservation and Recovery Act of 1976.

Recharge - The addition of water to the groundwater system by natural or artificial processes.

SAIC - Science Applications International Corporation

Sludge - Any inorganic or organic solids residues from a waste treatment plant, water supply treatment, or air pollution control facility; or other discarded material, including solid, liquid, semi-solid or solids which contain gaseous material resulting from industrial, commercial, mining or agricultural operations and community activities. Sludge does not include solid or dissolved materials in domestic sewage; solid or dissolved materials in irrigation return flows; industrial discharges which are point source subject to permits under Section 402 of the Federal Water Pollution Control Act, as amended (86 USC 880); or source, special nuclear, or by-product material as defined by the Atomic Energy Act of 1954 (68 USC 923).

Spill - Any unplanned release or discharge of a hazardous waste onto or into the air, land or water.

Split-Spoon Sampler - A sampling device used in borehole drilling that is fastened to the lower end of the drill stem to extract an undisturbed soil/rock sample. The sampler has a longitudinal seam which opens for sample retrieval.

Static Water Level - The undisturbed water level measured in a well which represents the potentiometric surface for an aquifer. It is generally expressed as feet below (or above) an arbitrary measuring datum near land surface.

Strata - (Plural of stratum) Units or layers of sedimentary rock.

Stratigraphic - Pertaining to the science of rock strata.

Subterranean - Formed or occurring beneath the earth's surface.

SWL - Static Water Level.

TDS - Total Dissolved Solids.

Thermistor - A temperature-sensing element composed of sintered semiconductor material which exhibits a large change in resistance proportional to a small change in temperature.

TOC - Total Organic Carbon.

Toxic - The ability of a material to produce injury or disease upon exposure, ingestion, inhalation, or assimilation by a living organism.

Treatment of Hazardous Waste - Any method, technique, or process in including neutralization designed to change the physical, chemical, or biological character or composition of any hazardous waste so as to neutralize the waste or so as to render the waste nonhazardous.

Unconfined - When used with groundwater, it is that groundwater that has a free water table; i.e., water not confined under pressure beneath relatively impermeable rocks.

Upgradient - In the direction of increasing hydraulic static head; the direction opposite to the prevailing flow of groundwater.

USAF - United States Air Force.

USGS - United States Geological Survey

Water Table - The surface between the zone of saturation and the zone of aeration; that surface of a body of unconfined groundwater at which the pressure is equal to that of the atmosphere.

Well Casing - Metal or plastic pipe lowered into a borehole during or after drilling and grouted in place.

Well Screen - Metal or plastic well casing that is perforated to allow the passage of groundwater usually for the purposes of water production or for monitoring groundwater quality.

APPENDIX C

SCOPE OF WORK

6 APR 1984

INSTALLATION RESTORATION PROGRAM

Phase II Field Evaluation

George AFB, California

I. Description of Work

The purpose of this task is to determine if environmental contamination has resulted from waste disposal practices at George AFB CA; to provide estimates of the magnitude and extent of contamination, should contamination be found; to identify any additional investigations and their attendant costs necessary to identify the magnitude, extent and direction of movement of discovered contaminants.

The presurvey report (mailed under separate cover) and Phase I IRP report (mailed under separate cover) incorporated background and description of the sites for this task. To accomplish the survey effort, the contractor shall take the following steps:

Ambient air monitoring of hazardous and/or toxic material for the protection of contractor and Air Force personnel shall be accomplished when necessary, especially during the drilling operation.

A. General

1. The contractor shall determine the areal extent of each zone by reviewing available photos and data, and by field reconnaissance.

2. Locations where soil samples are collected shall be marked with a permanent marker, and the location recorded on the project map for the zone.

3. Water sampling shall be accomplished only once at each location.

4. All water samples shall be analyzed on site by the contractor for pH, temperature and specific conductance. Other analyses are specified in paragraph I.B. Sampling, maximum holding time and preservation of samples shall strictly comply with the following references: Standard Methods for The Examination of Water and Wastewater, 15th Ed. (1980), pp. 35-42; ASTM, Part 31, pp. 72-82, (1976), Method D-3370; and Methods for Chemical Analysis of Waters and Wastes, EPA Manual 600/4-79-020, pp. xiii to xix (1979). Minimum detection limits for analyses are shown in Attachment 1.

5. Groundwater monitoring wells installed during this effort shall be completed to a depth of 20 feet below the surface of the groundwater table. Standard penetration tests and split spoon sampling shall be accomplished as the wells are installed. All wells shall be developed, water levels measured and locations surveyed and recorded on a project map and specific zone map.

6. Field data collected for each zone shall be plotted and mapped. The nature of contamination and the magnitude and potential for contaminant

flow within each zone to receiving streams and groundwaters shall be determined or estimated. Upon completion of the sampling and analysis, the data shall be tabulated in the next R&D Status Report as specified in Item VI below.

B. In addition to items delineated in A above, conduct the following specific actions at sites identified on George AFB.

1. Zone 1: Northeast Disposal Area (Sites S-21, L-13, S-5, S-6, S-20, S-25, L-12, L-11, B-9, B-8, B-10). Sites S-4, and the Central Disposal Area (Sites S-19, S-22, and S-23) shall be monitored as Zone 1.

a. Conduct an exfiltration test to locate perforated drain intervals along the Industrial Pipeline (Site S-20).

b. Collect soil samples along the Industrial Outfall (Site S-20) at depths of 5 and 10 feet for a total of 14 samples at seven locations. Composite the two samples from each location to obtain seven samples for purposes of analysis.

c. Based on the results of the exfiltration tests, soil samples, locations of the specific disposal sites listed above, and site geology, emplace five groundwater monitoring wells downgradient of the Northeast Disposal Area. At least three of the wells shall be along the north and northeast base boundaries. Collect one groundwater sample from each well.

d. Emplace one monitoring well downgradient from the Central Disposal Area. Collect one groundwater sample from the well.

e. Collect a maximum of seven soil samples from one monitoring well each in the Northeast Disposal Area and the Central Disposal Area at 10-foot intervals above the saturated zone. Perform a visual/odor screen on the samples, and select three samples from each well for analysis.

f. Analyze seven water and thirteen soil samples specified above as shown in Attachment 2.

g. Collect two soil samples at one foot depths within the roadway at Site S-4. Analyze each sample for oils and greases.

h. Review Air Force pressure test data and other leak test data provided by the Air Force for the jet fuel pipeline and storage tank system.

i. Analyze the validity of the pressure tests as an accurate indication of whether environmentally significant quantities of jet fuel has leaked from the system.

j. Make recommendations for follow-on monitoring of the jet fuel system based on this test evaluation as specified in Item I.E.2 below.

2. Zone 2: Southeast Disposal Area (Sites L-1, L-2, M-2, L-3). These sites shall be combined into one zone for the purposes of the Phase II Field Evaluation.

a. Perform a magnetometer survey at sites L-1 and L-3 to locate buried drums, if any.

b. Emplace four groundwater monitoring wells downgradient of the disposal sites. At least two of the wells shall be along the southeast base boundary. Collect one groundwater sample from each well.

c. Collect a maximum of seven soil samples from one of the monitoring wells at 10-foot intervals above the saturated zone. Perform a visual/odor screen on the samples, and select three samples for analysis.

d. Analyze each water (four maximum) and soil (three maximum) sample specified as shown in Attachment 2.

C. Well Installation and Cleanup

1. Ten wells shall be installed during this effort. Eight wells shall be drilled using hollow-stem auger techniques; two wells shall be drilled using mud-rotary technicues. Exact placement and drilling technique for each well shall be selected by the contractor in the field.

2. Well installations shall be cleaned following the completion of each well. Drill cuttings shall be removed and the general area cleaned.

D. Data Review

Results of sampling and analysis shall be tabulated and incorporated in the Informal Technical Information report (Sequence 3, Atch 1 and Seq 2, Atch 5 as reflected in Item VI below) and forwarded to USAF OEHL/TS for review.

E. Reporting

1. A draft report delineating all findings of this field investigation shall be prepared and forwarded to the USAF OEHL as specified in Item VI below for Air Force review and comment. This report shall include a discussion of the regional hydrogeology, well logs of all project wells, data from water level surveys, water quality analysis results, magnetometer survey results and maps, available geohydrologic cross sections, groundwater surface and gradient vector maps, vertical and horizontal flow vectors and Laboratory quality assurance information. The report shall follow the USAF OEHL supplied format (mailed under separate cover).

2. Estimates shall be made of the magnitude, extent and direction of movement of contaminants discovered. Potential environmental consequences of discovered contamination shall be identified or estimated. Where survey data are insufficient to properly determine or estimate the magnitude, extent and direction of movement of discovered contaminants, specific recommendations, fully justified, shall be made for additional efforts required to properly evaluate contaminant migration.

3. Specific requirements, if any, for future groundwater and surface water monitoring must be identified.

F. Cost Estimates

Detailed cost estimates for all additional work recommended for those sites in need of further determination or estimate of the magnitude, extent and direction of movement of discovered contaminants shall be provided, along with an estimate of the time required to accomplish the proposed effort. This information shall be provided in the final R&D Status Report and shall be included in a separate appendix to the draft final report.

II. Site Location and Dates:

George AFB CA
USAF Hospital/SGPB
Dates to be established

III. Base Support: None

IV. Government Furnished Property: None

ATTACHMENT 1

Analytic Methods and Required Detection Limits
(for water unless otherwise shown)

Analyte	Method	Detection Limit (μg/l)
*Total Organic Carbon (TOC)	EPA 415.1	1000
Oil and Grease (O&G)	EPA 413.2	100 (100 μg/g, soil)
*Total Organic Halogen (TOX)	EPA 9020	5 (5 μg/g, soil)
Chromium (Cr)	EPA 218.1	50 (5 μg/g, soil)
Lead (Pb)	EPA 239.2	20 (2 μg/g, soil)
Silver (Ag)	EPA 272.2	10 (1 μg/g, soil)
Phenol	EPA 420.1	1 (1 μg/g, soil)
PCB	EPA 608	0.25 μg/l (1 μg/g, soil)
DDT	Standard 509A	0.02 μg/l (0.02 μg/g, soil)
Chlordane	EPA 608	0.2 μg/l (0.2 μg/g, soil)

*For TOC and TOX analyses, report the noise level of the instrument. Laboratory distilled water must show no response; if it shows a response, corrections of positive results must be made.

APPENDIX D

WELL LOGS AND WELL CONSTRUCTION SUMMARIES

Table D-1

GUIDELINES FOR CLASSIFICATION OF SOILS

Cohesionless (Sands & Gravels)		Cohesive (Silts & Clays)	
N-Blows/ft[a]	Relative Density	N-Blows/ft[a]	Relative Consistency
0-4	Very Loose	2	Very Soft
4-10	Loose	2-4	Soft
10-30	Medium	4-8	Medium
30-50	Dense	8-15	Stiff
50	Very Dense	15-30	Very Stiff
		30	Hard

Grain Size Classification[b]

Inches	mm	Grade Name		
161.3	4096			
		Very Large	Boulders	GRAVEL
80.6	2048			
		Large		
40.3	1024			
		Medium		
20.2	512			
		Small		
10.1	256			
		Large	Cobbles	
5.0	128			
		Small		
2.52	64			
		Very Coarse	Pebbles	
1.26	32			
		Coarse		
0.63	16			
		Medium		
0.32	8			
		Fine		
0.16	4			
		Very Fine		
0.08	2			
		Very Coarse	Sand	SAND
0.04	1			
		Coarse		
	0.500			
		Medium		
	0.250			
		Fine		
	0.125			
		Very Fine		
	0.062			
		Coarse	Silt	MUD
	0.031			
		Medium		
	0.016			
		Fine		
	0.008			
		Very Fine		
	0.004			
		Coarse	Clay Size	
	0.002			
		Medium		
	0.001			
		Fine		
	0.0005			
		Very Fine		
	0.00025			

Modifier for Subclassification

0-1.5%[c]	Clean
1.5-10%	Trace
10-30%	Some
30-50%	Sandy,
30-50%	Silty, or
	Clayey

[a]Blows per foot standard penetration test.

[b]Modified Wentworth Scale--in Dietrich, et al., 1982.

[c]Percentage of dry weight of total sample.

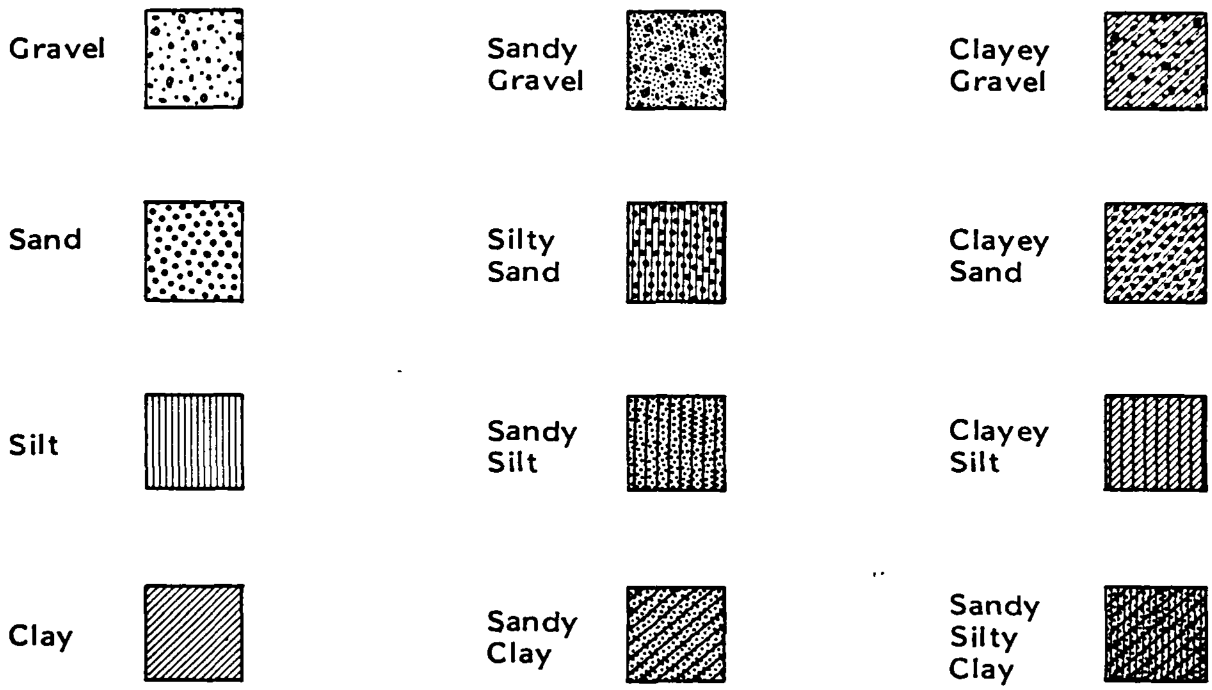


Figure D-1

GEOLOGIC SYMBOLS FOR UNCONSOLIDATED MATERIALS

JRB ASSOCIATES | WELL CONSTRUCTION SUMMARY

Project: George AFB IRP, Phase II Well ID: NZ01

DRILLING SUMMARY

Total Depth: 135'

Borehole Diameter: 8"

ELEVATION:

Land Surface: 2814.6

Top of Casing: 2817.7

Groundwater: 2709.6

Drilling Started: 05 Jan 84 (date) 0800 (time)

Geologist: Robert Peshkin

Driller: Howard Matthews

Stang Drilling & Exploration

Orange, CA

Rig Type: Mobile B-53

Bit(s): Paddle Tooth

Drilling Fluid: None

Drilling Completed: 07 Jan 84 (date) 1730 (time)

Technician:

NOTES: Patricia O'Flaherty assisted driller.

WELL DESIGN

BLANK CASING

Material: PVC

Diameter: 2.0" ID 2.375" OD

Depth: 0.0'-113.0'

SEALS: Type: Threaded

Filter Material: Backfilled Sand Cuttings

SLOTTED CASING

Material: PVC

Diameter: 2.0" ID 2.375" OD

Depth: 113.0'-133.0'

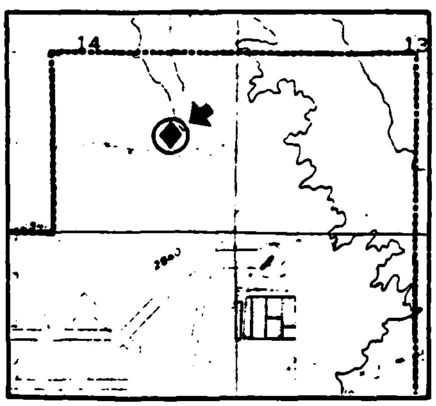
SEALS: Type: Threaded

GROUT: Type: Backfilled Sand Cuttings

Surface Monument: 48"x6" I.D. steel with locking cover.

NOTES:

SITE DESCRIPTION



Site Sketch

Location: Approximately 50 feet north of perimeter road, 50 feet west of drainage, north of north end of Runway 21.

Lambert Coordinates: 402649.3 N 2190376.6 E

Latitude: 34° 36' 17.3" N Longitude: 117° 22' 02.4" W

Twp: 6N Rge: 5W Sec: SE¼14

JRB ASSOCIATES

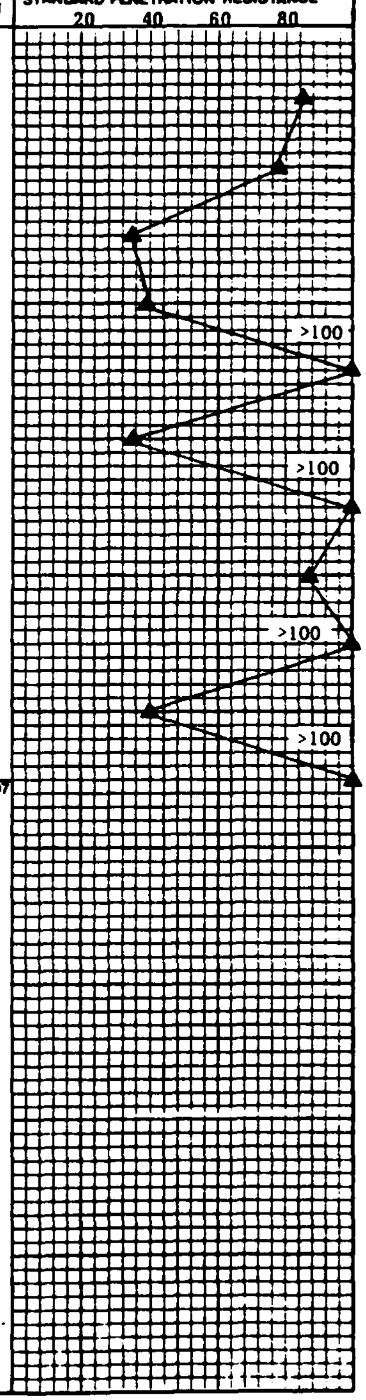
BORING LOG

PROJECT:	George AFB IRP, Phase II	LOCATION:	Victorville, California
WELL ID:	NZ01	DATE:	05 January - 07 January 1984
SURFACE ELEVATION:	2814.6	GROUNDWATER ELEVATION:	2709.6

ELEV.	DEPTH	GEOLOGIC DESCRIPTION
		0.0-11.0 Sand, medium, brown, some coarse, some clay, unconsolidated, well sorted, trace caliche with pea gravel.
2804.6	10	11.0-33.0 Sand, fine to medium, tan to yellow, clayey, slightly consolidated, well sorted.
2794.6	20	
2784.6	30	33.0-47.0 Sandy clay, tan with red streaks, abundant fine sand, well consolidated, well sorted.
2774.6	40	47.0-61.0 Sand, fine to medium, yellow to pink, unconsolidated, well sorted.
2764.6	50	
2754.6	60	61.0-91.0 Sandy clay, brown, abundant fine sand, silty, dense, well consolidated.
2744.6	70	
2734.6	80	
2724.6	90	91.0-135.0 Sand, fine to medium, increasing coarse sand with depth, brown, moderately consolidated, increasing density with depth, well sorted.
2714.6	100	
2704.6	110	
2694.6	120	
2684.6	130	Total Depth 135' 01/07/84
	140	
	150	
	160	
	170	
	180	
	190	

GRAPHIC LOG — SAMPLES — GROUND WATER (01/07)

STANDARD PENETRATION RESISTANCE



JRB ASSOCIATES

WELL CONSTRUCTION SUMMARY

Project: George AFB IRP, Phase II   Well ID: NZ02

DRILLING SUMMARY

Total Depth: 150'

Borehole Diameter: 4.5"

ELEVATION:

Land Surface: 2681.5

Top of Casing: 2684.7

Groundwater: (see notes)

Drilling Started: 12 Jun 84 (date) 1000 (time)

Geologist: Robert Peshkin

Driller: Elliott
Pioneer Drilling
Redlands, CA

Rig Type: Mobile B-80

Bit(s): Paddle Tooth Cutter

Drilling Fluid: Bentonite Slurry

Drilling Completed: 12 Jun 84 (date) 1400 (time)

Technician:

NOTES: No soil samples taken during drilling. Groundwater surface elevation unknown at time of drilling due to fluid drilling technique.

WELL DESIGN

BLANK CASING

Material: PVC

Diameter: 2.0" ID 2.375" OD

Depth: 0'-130.0'

SEALS: Type: Threaded

Filter Material: Silica Sand (16 grade)

SLOTTED CASING

Material: PVC

Diameter: 2.0" ID 2.375" OD

Depth: 130.0'-150.0'

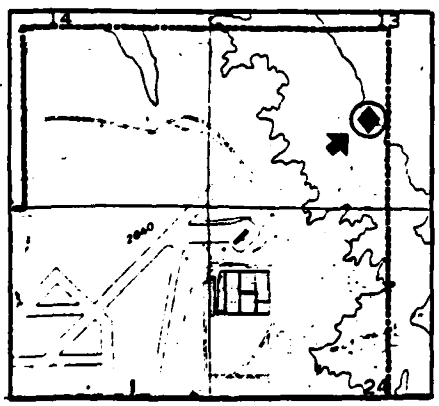
SEALS: Type: Threaded

GROUT: Type: Bentonite/cement

Surface Monument: 48"x6" I.D. steel with locking cover.

NOTES:

SITE DESCRIPTION



Site Sketch

Location: Adjacent to east boundary in NE corner of base. East of ALERT facility at north end of Runway 21, north of NZ03.

Lambert Coordinates: 402699.4 N 2193913.9 E

Latitude: 34° 36' 17.5" N   Longitude: 117° 21' 20.1" W

Twp: 6N   Rge: 5W   Sec: E½SW¼13

JRB ASSOCIATES | WELL CONSTRUCTION SUMMARY

Project: George AFB IRP, Phase II   Well ID: NZ03

DRILLING SUMMARY

Total Depth: 150'

Borehole Diameter: 4.5"

ELEVATION:

Land Surface: 2725.6

Top of Casing: 2728.1

Groundwater: (see notes)

Drilling Started: 13 Jun 84 (date) 0900 (time)

Geologist: Robert Peshkin

Driller: Elliott
Pioneer Drilling
Redlands, CA

Rig Type: Mobile B-80

Bit(s): Paddle Tooth Cutter

Drilling Fluid: Bentonite Slurry

Drilling Completed: 13 Jun 84 (date) 1245 (time)

Technician:

NOTES: No soil samples taken during drilling. Groundwater surface elevation unknown at time of drilling due to fluid drilling technique.

WELL DESIGN

BLANK CASING

Material: PVC

Diameter: 2.0" ID 2.375" OD

Depth: 0.0'-130.0'

SEALS: Type: Threaded

Filter Material: Silica Sand (16 grade)

SLOTTED CASING

Material: PVC

Diameter: 2.0" ID 2.375" OD

Depth: 130.0'-150.0'

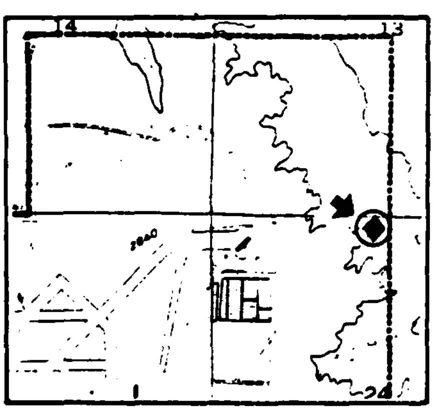
SEALS: Type: Threaded

GROUT: Type: Bentonite/Cement

Surface Monument: 48" x 6" I.D. Steel with locking cover

NOTES:

SITE DESCRIPTION



Site Sketch

Location: Adjacent to east boundary in NE corner of base. East of ALERT facility at north end of Runway 21.

Lambert Coordinates: 401653.4 N 2193931.1 E

Latitude: 34° 36' 07.2" N   Longitude: 117° 21' 20.0" W

Twp: 6N   Rge: 5W   Sec: NE¼NW¼24

JRB ASSOCIATES

WELL CONSTRUCTION SUMMARY

Project: George AFB IRP, Phase II

Well ID: NZ04

DRILLING SUMMARY

Total Depth: 137'

Borehole Diameter: 8"

ELEVATION:

Land Surface: 2844.2

Top of Casing: 2846.8

Groundwater: 2727.2

Drilling Started: 9 Jan 84 (date) 0730 (time)

Geologist: Robert Peshkin

Driller: Howard Matthews
Stang Drilling & Exploration
Orange, CA

Rig Type: Mobile B-53

Bit(s): Paddle Tooth

Drilling Fluid: None

Drilling Completed: 9 Jan 84 (date) 1730 (time)

Technician:

NOTES: Patricia O'Flaherty assisted driller.

WELL DESIGN

BLANK CASING

Material: PVC

Diameter: 2.0" ID 2.375" OD

Depth: 0.0'-117.0'

SEALS: Type:

Filter Material: Backfilled Sand Cuttings

SLOTTED CASING

Material: PVC

Diameter: 2.0" ID 2.375" OD

Depth: 117.0'-137.0'

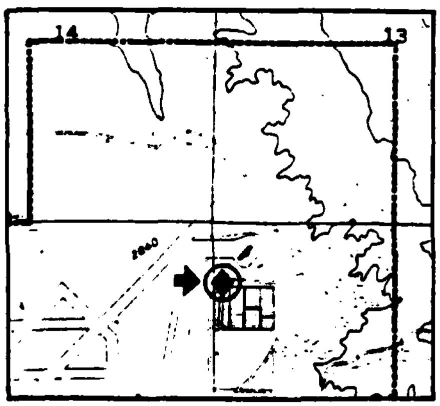
SEALS: Type:

GROUT: Type: Bentonite/Cement

Surface Monument: 48" x 6" I.D. Steel with locking cover.

NOTES:

SITE DESCRIPTION



Site Sketch

Location: Approximately 50 feet north of old sewage treatment plant near the north end of Runway 21.

Lambert Coordinates: 400396.4 N 2191307.7 E

Latitude: 34° 35' 54.9" N Longitude: 117° 21' 51.5" W

Twp: 6N Rge: 5W Sec: NE¼NE¼23

JRB ASSOCIATES

BORING LOG

PROJECT: George AFB IRP, Phase II **LOCATION:** Victorville, California

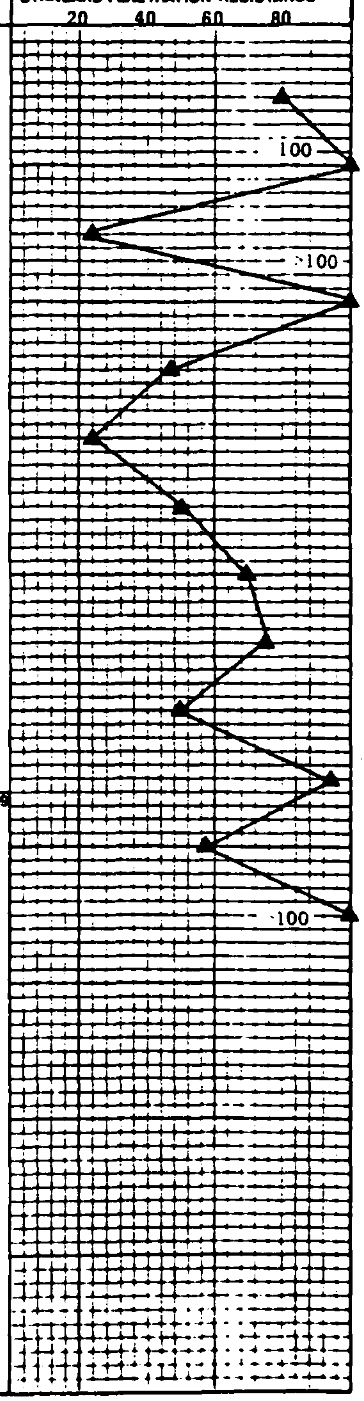
WELL ID: NZ04 **DATE:** 09 January 1984

SURFACE ELEVATION: 2844.2 **GROUNDWATER ELEVATION:** 2727.2

ELEV.	DEPTH	GEOLOGIC DESCRIPTION
2834.2	10	0.0-29.0 Sand, medium to coarse, brown to pink, some silt, some clay, trace gravel, trace caliche with gravel, moderately consolidated, well sorted.
2824.2	20	
2814.2	30	29.0-40.0 Clayey sand, fine, some medium, tan to pink, well consolidated.
2804.2	40	40.0-52.0 Sand, fine to medium, brown to pink, trace pea gravel, moderately consolidated, well sorted.
2794.2	50	52.0-109.0 Sand, fine, brown, some medium, clayey to very clayey, some silt, dense, moderately to well consolidated, well sorted.
2784.2	60	
2774.2	70	
2764.2	80	
2754.2	90	
2744.2	100	
2734.2	110	109.0-137.0 Sand, fine to medium, brown, some pink, silty, some clay, moderately consolidated, well sorted.
2724.2	120	
2714.2	130	
	140	Total Depth 137' 01/09/84
	150	
	160	
	170	
	180	
	190	

GROUND WATER: 01/09

STANDARD PENETRATION RESISTANCE



JRB ASSOCIATES | WELL CONSTRUCTION SUMMARY

Project: George AFB IRP, Phase II   Well ID: NZ05

DRILLING SUMMARY

Total Depth: 140'

Borehole Diameter: 8"

ELEVATION:

Land Surface: 2864.4

Top of Casing: 2867.2

Groundwater: 2743.4

Drilling Started: 31 Jan 84 (date) 0915 (time)

Geologist: Robert Peshkin

Driller: David Sumney
Stang Drilling & Exploration
Orange, CA

Rig Type: Mobile B-53

Bit(s): Paddle Tooth

Drilling Fluid: None

Drilling Completed: 31 Jan 84 (date) 2130 (time)

Technician:

NOTES: Chemical analysis of soil samples taken at 86.0, 111.5, and 135.9 feet.

WELL DESIGN

BLANK CASING

Material: PVC

Diameter: 2.0" ID 2.375" OD

Depth: 0.0'-120.0'

SEALS: Type: Threaded

Filter Material: Backfilled Sand Cuttings

SLOTTED CASING

Material: PVC

Diameter: 2.0" ID 2.375" OD

Depth: 120.0'-140.0'

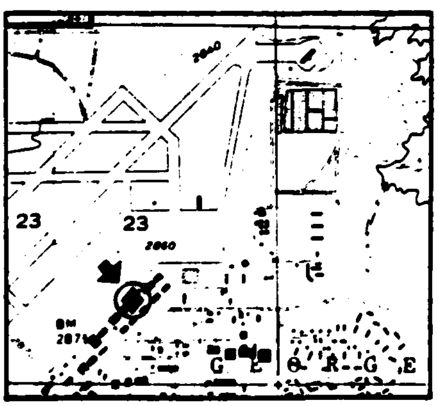
SEALS: Type: Threaded

GROUT: Type: Bentonite/Cement

Surface Monument: 48" x 6" I.D. Steel with locking cover.

NOTES:

SITE DESCRIPTION



Site Sketch

Location: Adjacent to the north side of Building 734.

Lambert Coordinates: 397220.2 N 2189212.7 E

Latitude: 34° 35' 23.6" N   Longitude: 117° 22' 16.8" W

Twp: 6N   Rge: 5W   Sec: SW¼SE¼23

JRB ASSOCIATES

BORING LOG

PROJECT: George AFB IRP, Phase II **LOCATION:** Victorville, California

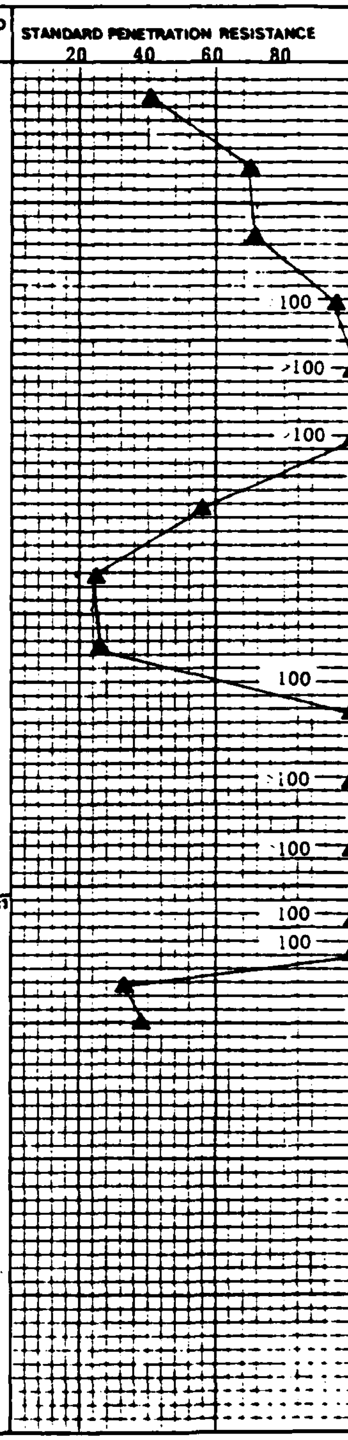
WELL ID: NZ05 **DATE:** 31 January 1984

SURFACE ELEVATION: 2864.4 **GROUNDWATER ELEVATION:** 2743.4

ELEV.	DEPTH	GEOLOGIC DESCRIPTION
		0.0-65.0 Sand, fine to very fine, light brown to olive green, trace very coarse sand, trace pea gravel, moderately consolidated, well sorted.
2854.4	10	
2844.4	20	
2834.4	30	35.0-37.0 Sand, as above, abundant Fe staining.
2824.4	40	
2814.4	50	
2804.4	60	65.0-80.0 Clayey sand, green to green/brown, very silty, well consolidated, some sorting, decreasing clay with depth.
2794.4	70	
2784.4	80	80.0-81.0 Clayey pea gravel. 81.0-140.0 Sand, medium to fine, light brown, some pink, some coarse to very coarse, moderately to well consolidated, slightly to poorly sorted.
2774.4	90	
2764.4	100	105.0 Sand, as above, very clayey.
2754.4	110	
2744.4	120	
2734.4	130	
2724.4	140	Total Depth 140' 01/31/84
	150	
	160	
	170	
	180	
	190	

GROUND WATER: 01/31

STANDARD PENETRATION RESISTANCE



*Samples selected for chemical characterization as determined by organic vapor analysis of soil sample.

JRB ASSOCIATES | **WELL CONSTRUCTION SUMMARY**

Project: George AFB IRP, Phase II Well ID: CZ01

DRILLING SUMMARY

Total Depth: 163'

Borehole Diameter: 8"

ELEVATION:

Land Surface: 2881.9

Top of Casing: 2884.2

Groundwater: 2746.9

Drilling Started: 11 Jan 84 (date) 0730 (time)

Geologist: Robert Peshkin

Driller: Howard Matthews

Stang Drilling & Exploration

Orange, CA

Rig Type: Mobile B-53

Bit(s): Paddle Tooth

Drilling Fluid: None

Drilling Completed: 12 Jan 84 (date) 1800 (time)

Technician:

NOTES: Patricia O'Flaherty assisted driller. Chemical analysis of soil samples taken at 50.0, 70.5, and 140.5 feet.

WELL DESIGN

BLANK CASING

Material: PVC

Diameter: 2.0" ID 2.375" OD

Depth: 0.0'-143.0'

SEALS: Type: Threaded

Filter Material: Backfilled Sand Cuttings

SLOTTED CASING

Material: PVC

Diameter: 2.0" ID 2.375" OD

Depth: 143.0'-163.0'

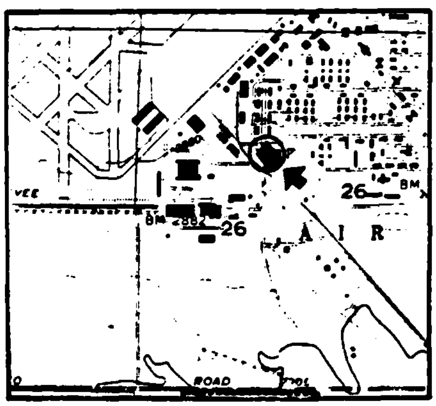
SEALS: Type: Threaded

GROUT: Type: Bentonite/Cement

Surface Monument: 48"x6" I.D. steel pipe with locking cover.

NOTES:

SITE DESCRIPTION



Site Sketch

Location: Adjacent to the west side of Bldg. 520 approximately 25' south of the SW corner of the intersection of Phantom Ave. and Sabre St.

Lambert Coordinates: 394303.4 N 2187910.6 E

Latitude: 34° 34' 54.8" N Longitude: 117° 22' 32.6" W

Twp: 6N Rge: 5W Sec: SE¼NW¼26

JRB ASSOCIATES

— BORING LOG —

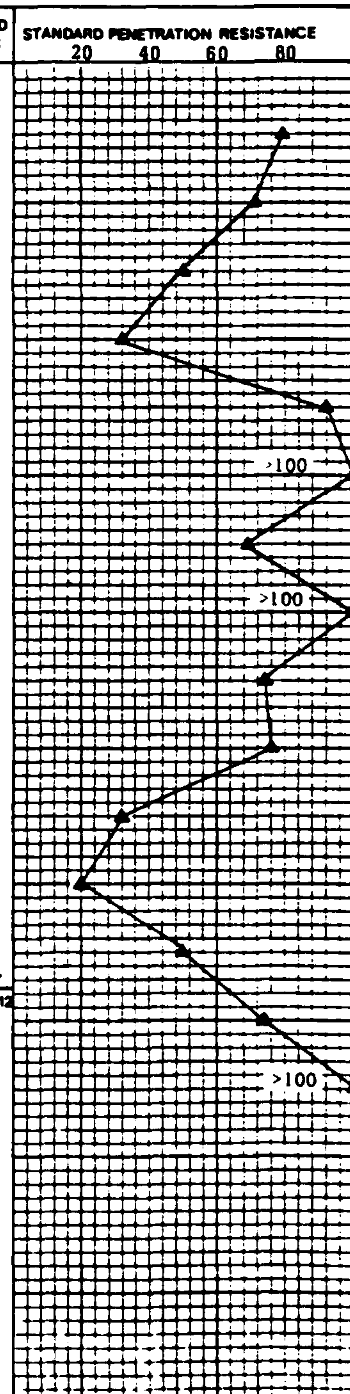
PROJECT: George AFB IRP, Phase II **LOCATION:** Victorville, California

WELL ID: CZ01 **DATE:** 11 January - 12 January 1984

SURFACE ELEVATION: 2881.8 **GROUNDWATER ELEVATION:** 2746.9

ELEV.	DEPTH	GEOLOGIC DESCRIPTION	SAMPLES	GROUND WATER
		0.0-50.0 Silty sand, fine to medium, brown to gray, clayey, unconsolidated, well sorted.		
2871.8	10			
2861.8	20			
2851.8	30			
2841.8	40			
2831.8	50	50.0-60.0 Sand, coarse to medium, tan to pink, some pea gravel, silty, unconsolidated, poorly sorted.	*	
2821.8	60	60.0-163.0 Silty sand, fine to medium, trace coarse sand, brown, clayey to very clayey in places, unconsolidated, well sorted.		
2811.8	70		*	
2801.8	80			
2791.8	90			
2781.8	100			
2771.8	110			
2761.8	120			
2751.8	130			01/12
2741.8	140		*	
2731.8	150			
2721.8	160	Total Depth 165' 01/12/84		
	170			
	180			
	190			

STANDARD PENETRATION RESISTANCE



*Samples selected for chemical characterization as determined by organic vapor analysis of soil sample.

JRB ASSOCIATES

WELL CONSTRUCTION SUMMARY

Project: George AFB IRP, Phase II

Well ID: SZ01

DRILLING SUMMARY

Total Depth: 185'

Borehole Diameter: 8"

ELEVATION:

Land Surface: 2925.9

Top of Casing: 2928.6

Groundwater: 2759.9

Drilling Started: 31 Jan 84 (date) (time)

Geologist: Robert Peshkin

Driller: David Sumney
Stang Drilling & Exploration
Orange, CA

Rig Type: Mobile B-53

Bit(s): Paddle Tooth

Drilling Fluid: None

Drilling Completed: 03 Feb 84 (date) 1800 (time)

Technician:

NOTES:

WELL DESIGN

BLANK CASING

Material: PVC

Diameter: 2.0" ID 2.375" OD

Depth: 0.0'-165.0'

SEALS: Type: Threaded

Filter Material: Backfilled Sand Cuttings

SLOTTED CASING

Material: PVC

Diameter: 2.0" ID 2.375" OD

Depth: 165.0'-185.0'

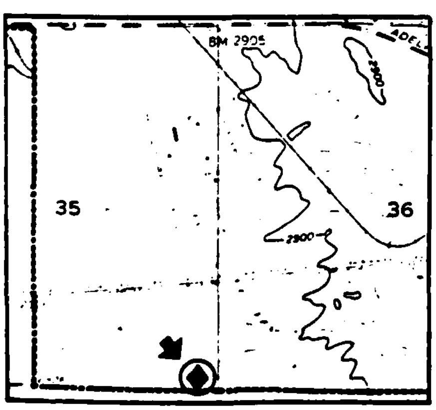
SEALS: Type: Threaded

GROUT: Type: Bentonite/Cement

Surface Monument: 48" x 6" I.D. Steel with locking cover.

NOTES:

SITE DESCRIPTION



Site Sketch

Location: South of munitions storage facility in unsecured portion of base south of Air Base Road.

Lambert Coordinates: 385419.1 N 2191504.2 E

Latitude: 34° 33' 26.7" N

Longitude: 117° 21' 50.3" W

Twp: 6N

Rge: 5W

Sec: SW¼SW¼35

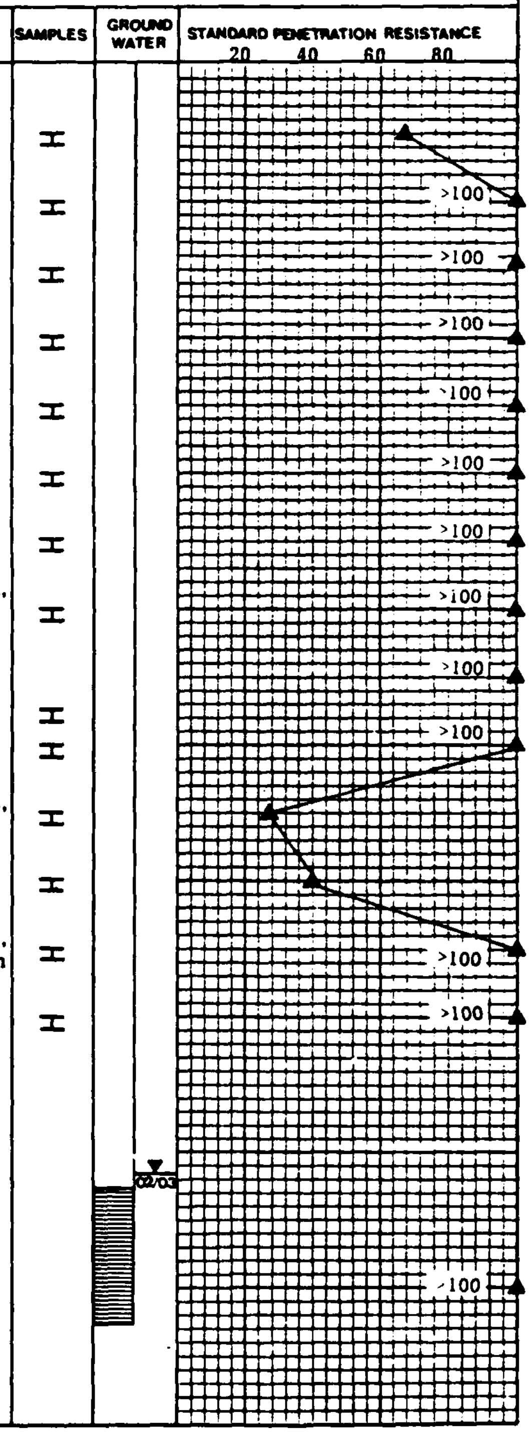
JRB ASSOCIATES

— BORING LOG —

PROJECT	George AFB IRP, Phase II	LOCATION:	Victorville, California
WELL ID:	SZ01	DATE:	31 January - 03 February 1984
SURFACE ELEVATION:	2925.9	GROUNDWATER ELEVATION:	2759.9

ELEV.	DEPTH	GEOLOGIC DESCRIPTION
		0.0-60.0 Sand, very fine to very coarse, light brown, some gray, some white, trace pebbles, trace angular gravel, unconsolidated poorly sorted, increased sorting with depth.
2915.9	10	
2905.9	20	
2895.9	30	
2885.5	40	
2875.5	50	
2865.5	60	60.0-70.0 Clayey sand, medium to coarse, brown to light brown, dense, moderately consolidated, poorly sorted.
2855.5	70	70.0-95.0 Sand, medium, some fine, trace coarse, unconsolidated, well sorted.
2845.5	80	
2835.5	90	95.0-100.0 Sandy silty clay, medium to coarse, some very coarse, brown, dense, well consolidated, well sorted.
2825.5	100	100.0-120.0 Sand, fine to medium, light brown to pink, unconsolidated, well sorted, increasing clay with depth.
2815.5	110	
2805.5	120	120.0 Clay, brown, very consolidated, very dense. 120.0-160.0 Sand, fine to medium, some coarse to very coarse, brown to light red/brown, trace gravel, unconsolidated, well sorted.
2795.5	130	
2785.5	140	
2775.5	150	
2765.5	160	160.0-185.0 No recovery.
2755.5	170	
2745.5	180	Total Depth 185' 02/03/84
	190	

SAMPLES | GROUND WATER | STANDARD PENETRATION RESISTANCE



JRB ASSOCIATES | WELL CONSTRUCTION SUMMARY

Project: George AFB IRP, Phase II   Well ID: SZ02

DRILLING SUMMARY

Total Depth: 115'
Borehole Diameter: 8"
ELEVATION:
Land Surface: 2821.6
Top of Casing: 2825.1
Groundwater: 2735.1
Drilling Started: 04 Feb 84 (date) 0945 (time)
Geologist: Robert Peshkin

Driller: David Sumney
Stang Drilling & Exploration
Orange, CA
Rig Type: Mobile B-53
Bit(s): Paddle Tooth
Drilling Fluid: None
Drilling Completed: 04 Feb 84 (date) 2000 (time)
Technician:

NOTES: Chemical analysis of soil samples taken at 55, 75, and 95 feet.

WELL DESIGN

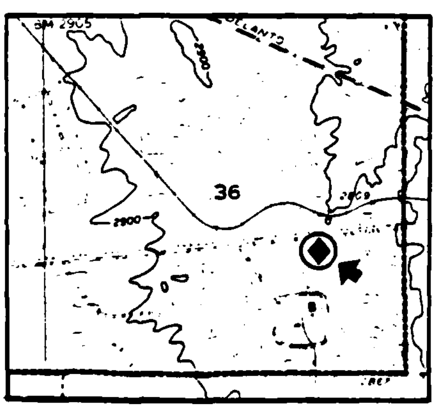
BLANK CASING
Material: PVC
Diameter: 2.0" ID 2.375" OD
Depth: 0.0'-95.0'
SEALS: Type: Threaded
Filter Material: Backfilled Sand Cuttings

SLOTTED CASING
Material: PVC
Diameter: 2.0" ID 2.375" OD
Depth: 95.0'-115.0'
SEALS: Type: Threaded
GROUT: Type: Bentonite/Cement

Surface Monument: 48" x 6" I.D. Steel with locking cover.

NOTES:

SITE DESCRIPTION



Site Sketch

Location: South of powerline road, north of old grenade range, east of SZ03 in unsecured SE portion of base south of Air Base Road.

Lambert Coordinates: 387094.2 N 2195069.5 E

Latitude: 34° 33; 43.1" N   Longitude: 117° 21' 07.5" W

Twp: 6N   Rge: 5W   Sec: N½SE¼36

JRB ASSOCIATES

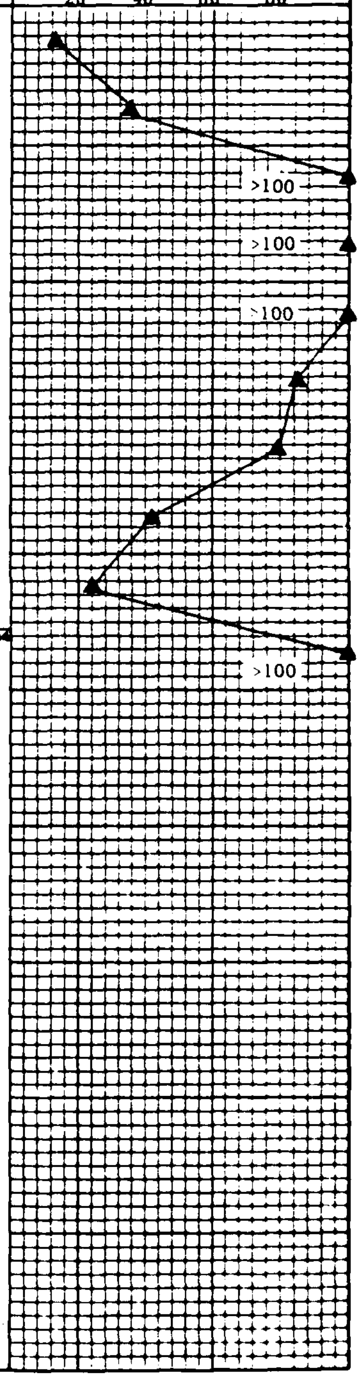
BORING LOG

PROJECT:	George AFB IRP, Phase II	LOCATION:	Victorville, California
WELL ID:	SZ02	DATE:	04 February 1984
SURFACE ELEVATION:	2821.6	GROUNDWATER ELEVATION:	2735.1

ELEV.	DEPTH	GEOLOGIC DESCRIPTION	SAMPLES
		0.0-115.0 Sand, medium, some fine, brown to light brown, trace coarse to very coarse, unconsolidated, increased sorting with depth, increased consolidation with depth.	I
2811.6	10		I
2801.6	20		I
2791.6	30		I
2781.6	40		I
2771.6	50		I*
2761.6	60		I
2751.6	70		
		75.0 Clay, green to gray/green, very dense, very well consolidated very sandy with depth.	I*
2741.6	80		I
2731.6	90		I*
2721.6	100		
2711.6	110		
		Total Depth 115' 02/04/84	
	120		
	130		
	140		
	150		
	160		
	170		
	180		
	190		

GROUND WATER: 02/04

STANDARD PENETRATION RESISTANCE



*Samples selected for chemical characterization as determined by organic vapor analysis of soil sample.

JRB ASSOCIATES

WELL CONSTRUCTION SUMMARY

Project: George AFB IRP, Phase II　　Well ID: SZ03

DRILLING SUMMARY

Total Depth: 150'

Borehole Diameter: 8"

ELEVATION:

- Land Surface: 2862.7
- Top of Casing: 2865.5
- Groundwater: 2736.7

Drilling Started: 5 Feb 84 (date) 0940 (time)

Geologist: Robert Peshkin

Driller: David Sumney
Stang Drilling & Exploration
Orange, CA

Rig Type: Mobile B-53

Bit(s): Paddle Tooth

Drilling Fluid: None

Drilling Completed: 5 Feb 84 (date) 2130 (time)

Technician:

NOTES:

WELL DESIGN

BLANK CASING

- Material: PVC
- Diameter: 2.0" ID 2.375" OD
- Depth: 0.0'-130.0'

SEALS: Type: Threaded

Filter Material: Backfilled Sand Cuttings

SLOTTED CASING

- Material: PVC
- Diameter: 2.0" ID 2.375" OD
- Depth: 130.0'-150.0'

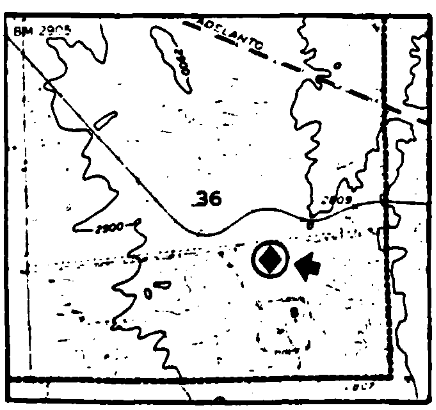
SEALS: Type: Threaded

GROUT: Type: Bentonite/Cement

Surface Monument: 48" x 6" I.D. Steel with locking cover.

NOTES:

SITE DESCRIPTION



Site Sketch

Location: South of powerline road, north of south landfill, SE of munitions storage facility, west of SZ02 in unsecured SE portion of base south of Air Base Road.

Lambert Coordinates: 383813.7 N 2193968.3 E

Latitude: 34° 33' 40.4" N　　Longitude: 117° 21' 29.2" W

Twp: 6N　　Rge: 5W　　Sec: NW¼SE¼36

JRB ASSOCIATES

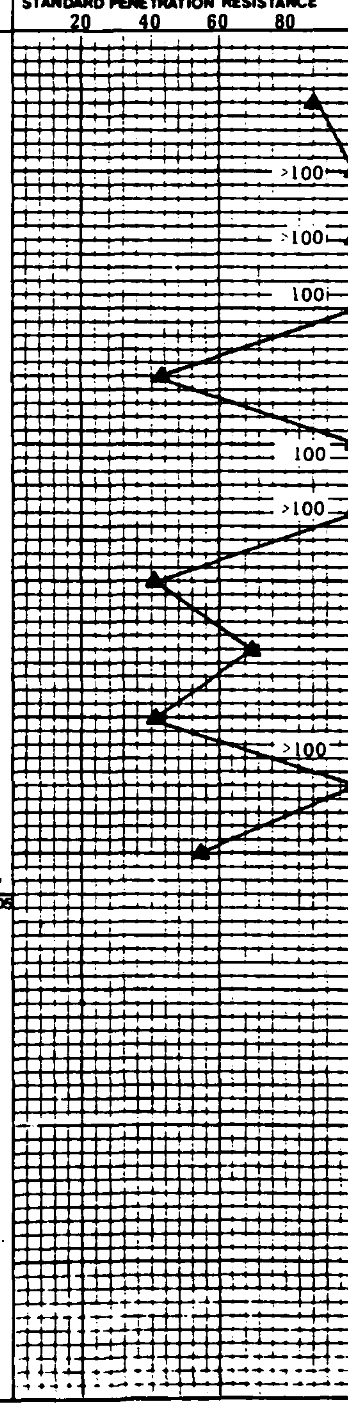
— BORING LOG —

PROJECT:	George AFB IRP, Phase II	LOCATION:	Victorville, California
WELL ID:	SZ03	DATE:	05 February 1984
SURFACE ELEVATION:	2862.7	GROUNDWATER ELEVATION:	2736.7

ELEV.	DEPTH	GEOLOGIC DESCRIPTION	SAMPLES
		0.0-75.0 Sand, medium to fine, light brown to green/brown, trace silt, trace gravel, unconsolidated, well sorted.	
2852.7	10		I
2842.7	20		I
2832.7	30		I
2822.7	40		I
2812.7	50	50.0 Sand silty clay, gray to gray/green, very well consolidated, dense.	I
2802.7	60		I
2792.7	70		I
		75.0-95.0 Clayey sand, fine to very fine, brown to brown/green.	
2782.7	80		I
2772.7	90		I
		95.0-120.0 Sand, medium to very coarse, reddish/brown, very Fe stained, trace gravel, moderately consolidated, well sorted.	
2762.7	100		I
2752.7	110		I
2742.7	120	120.0 Sandy silty clay, green, dense, well consolidated. 120.0-150.0 No recovery.	I
2732.7	130		
2722.7	140		
2712.7	150	Total Depth 150' 02/05/84	
	160		
	170		
	180		
	190		

GROUND WATER: 02/05

STANDARD PENETRATION RESISTANCE



JRB ASSOCIATES | WELL CONSTRUCTION SUMMARY

Project: George AFB IRP, Phase II   Well ID: SZ04

DRILLING SUMMARY

Total Depth: 160'

Borehole Diameter: 8"

ELEVATION:

Land Surface: 2890.3

Top of Casing: 2893.4

Groundwater: 2753.3

Drilling Started: 9 Apr 84 (date) 0830 (time)

Geologist: Robert Peshkin

Driller: David Sumney

Stang Drilling & Exploration

Orange, CA

Rig Type: Mobile B-53

Bit(s): Paddle Tooth

Drilling Fluid: None

Drilling Completed: 11 Apr 84 (date) 1000 (time)

Technician:

NOTES:

WELL DESIGN

BLANK CASING

Material: PVC

Diameter: 2.0" ID 2.375" OD

Depth: 0.0'-140.0'

SEALS: Type: Threaded

Filter Material: Backfilled Sand Cuttings

SLOTTED CASING

Material: PVC

Diameter: 2.0" ID 2.375" OD

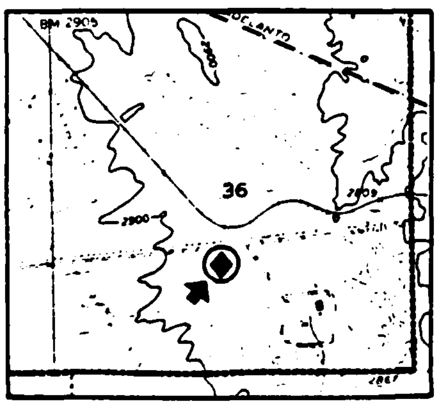
Depth: 140.0'-160.0'

GROUT: Type: Bentonite/Cement

Surface Monument: 48" x 6" I.D. Steel with locking cover.

NOTES:

SITE DESCRIPTION



Site Sketch

Location: South of powerline road, north of south landfill, SE of munitions storage facility, west of SZ03 in unsecured SE portion of base south of Air Base Road.

Lambert Coordinates: 386904.1 N 2193258.2 E

Latitude: 34° 33' 41.3" N   Longitude: 117° 21' 29.2" W

Twp: 6N   Rge: 5W   Sec: NE¼SW¼36

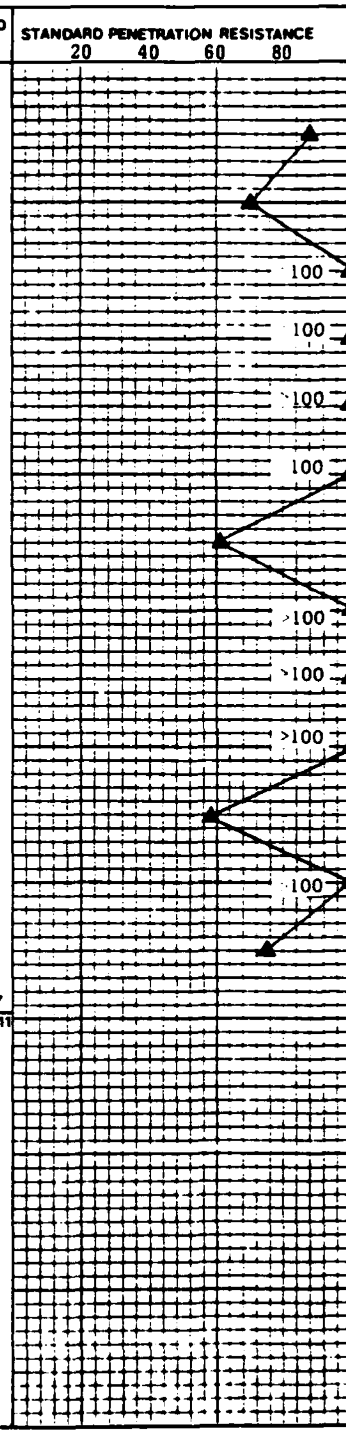
JRB ASSOCIATES

BORING LOG

PROJECT:	George AFB IRP, Phase II	LOCATION:	Victorville, California
WELL ID:	SZ04	DATE:	09 April - 11 April 1984
SURFACE ELEVATION:	2890.3	GROUNDWATER ELEVATION:	2753.3

ELEV.	DEPTH	GEOLOGIC DESCRIPTION	SAMPLES
		0.0-55.0 Sand, very fine to very coarse, light brown to tan, moderately consolidated, poorly sorted.	
2880.3	10		H
2870.3	20		H
2860.3	30		H
2850.3	40		H
2840.3	50		H
		55.0-75.0 Sandy silty clay, light brown-brown/green, very well consolidated, well sorted, dense.	
2830.3	60		H
2820.3	70		H
		75.0-125.0 Sand, very fine to medium, light brown to tan, well consolidated, friable, moderately sorted.	
2810.3	80		H
2800.3	90		H
2790.3	100		H
2780.3	110		H
2770.3	120		H
		125.0 Sandy clay, dark green to brown, fine to medium sand, well consolidated, moderately sorted, abundant FeS, dense.	
2760.3	130		H
		135.0-160.0 No recovery.	
2750.3	140		H
2740.3	150		
2730.3	160	Total Depth 160' 04/11/84	
	170		
	180		
	190		

GROUND WATER



APPENDIX E

MAGNETIC SURVEY GRADIENT PLOTS

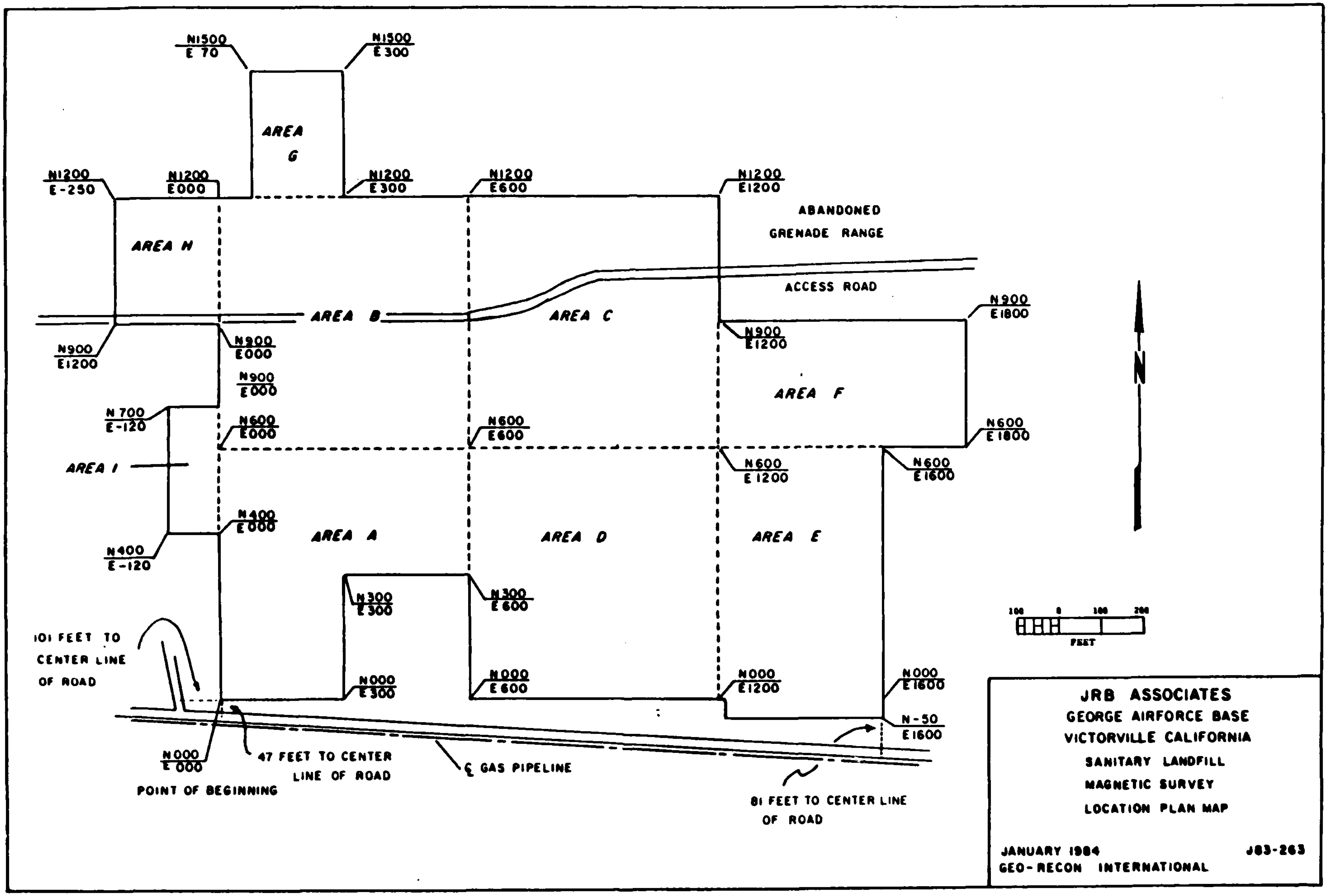


Figure E-1

Landfill Magnetic Survey Locator Map for Figures E-2 - E-19

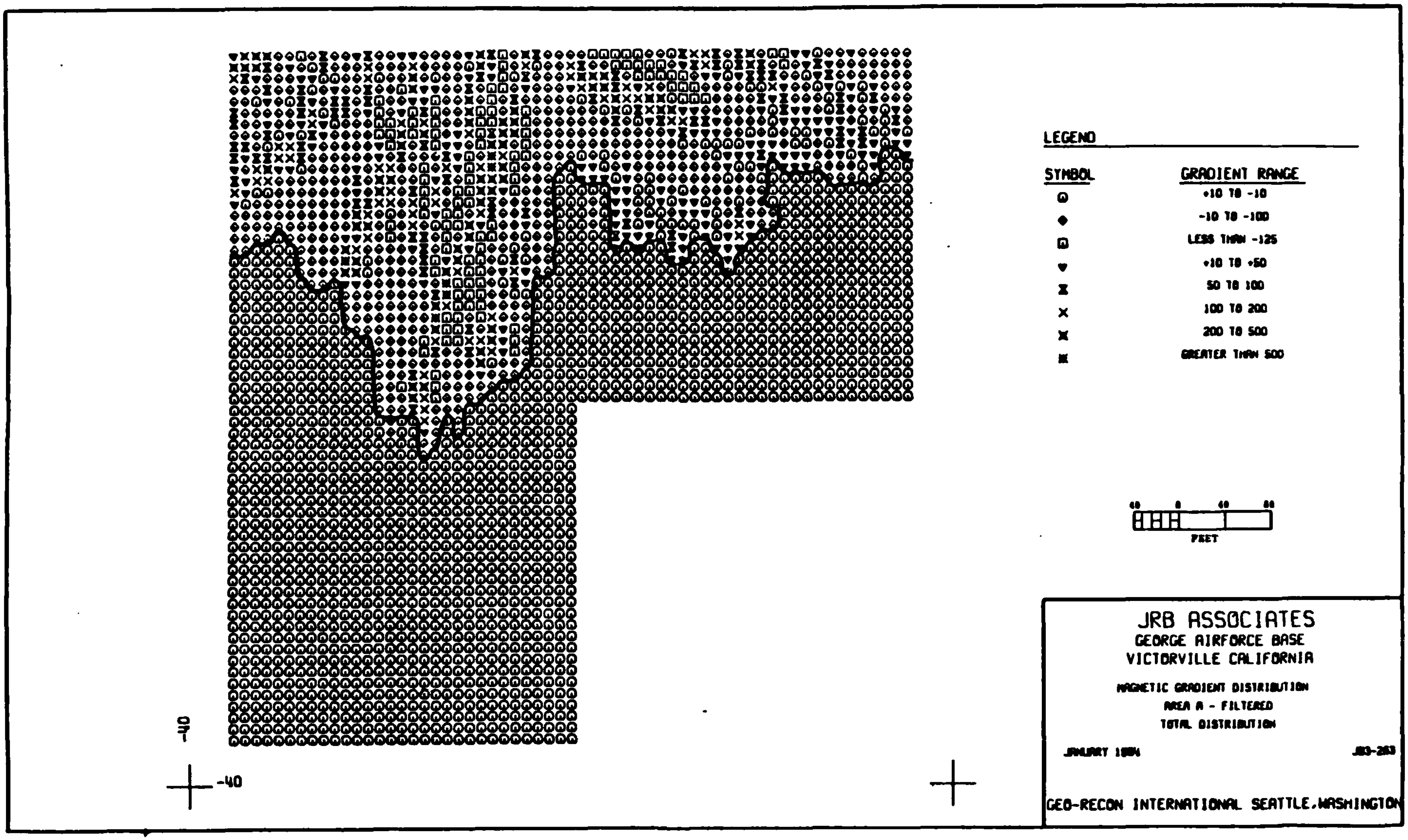


Figure E-2

Area A - Filtered Magnetic Total Gradient Distribution

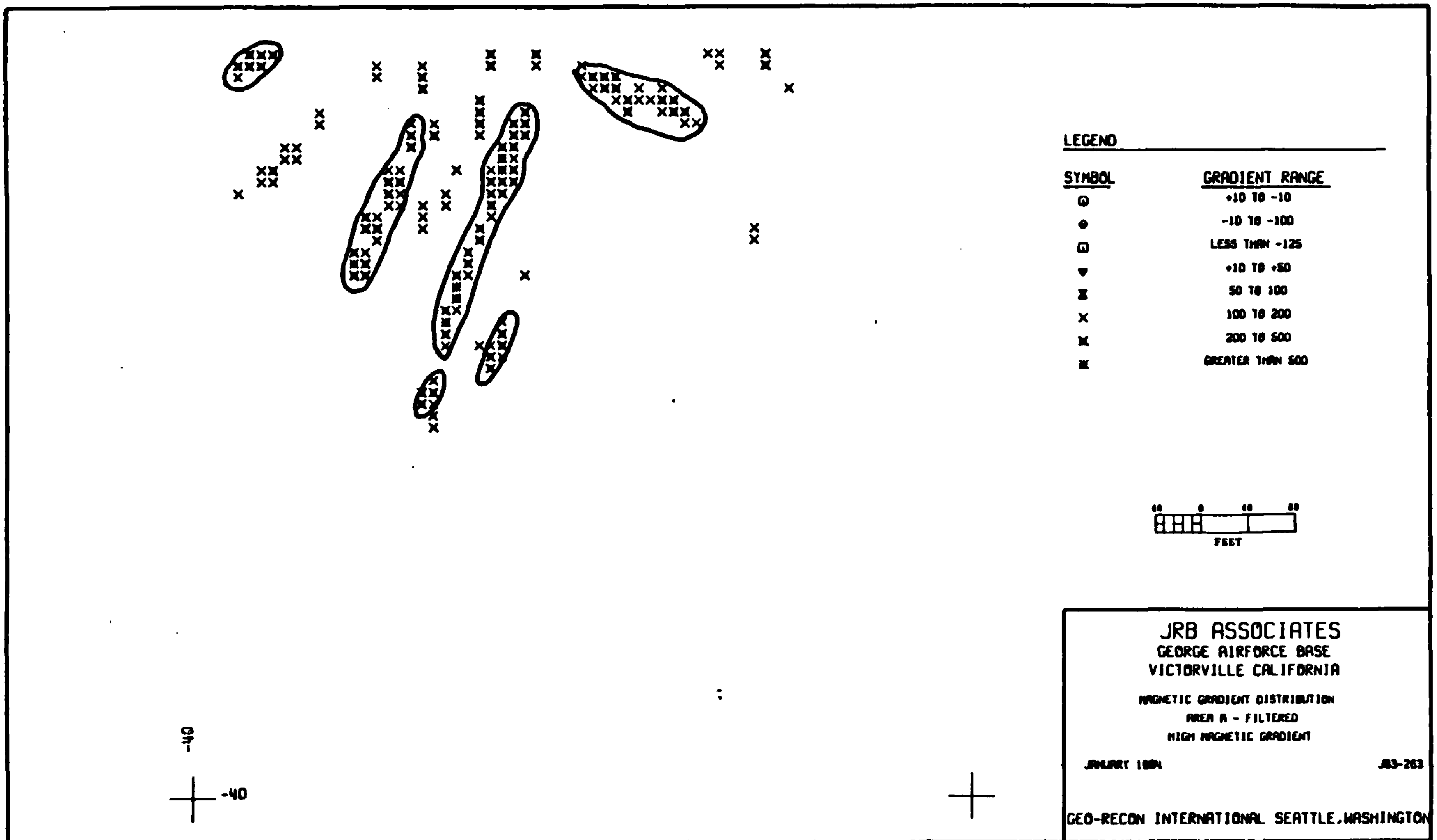


Figure E-3

Area A - Filtered Magnetic High Gradient Distribution

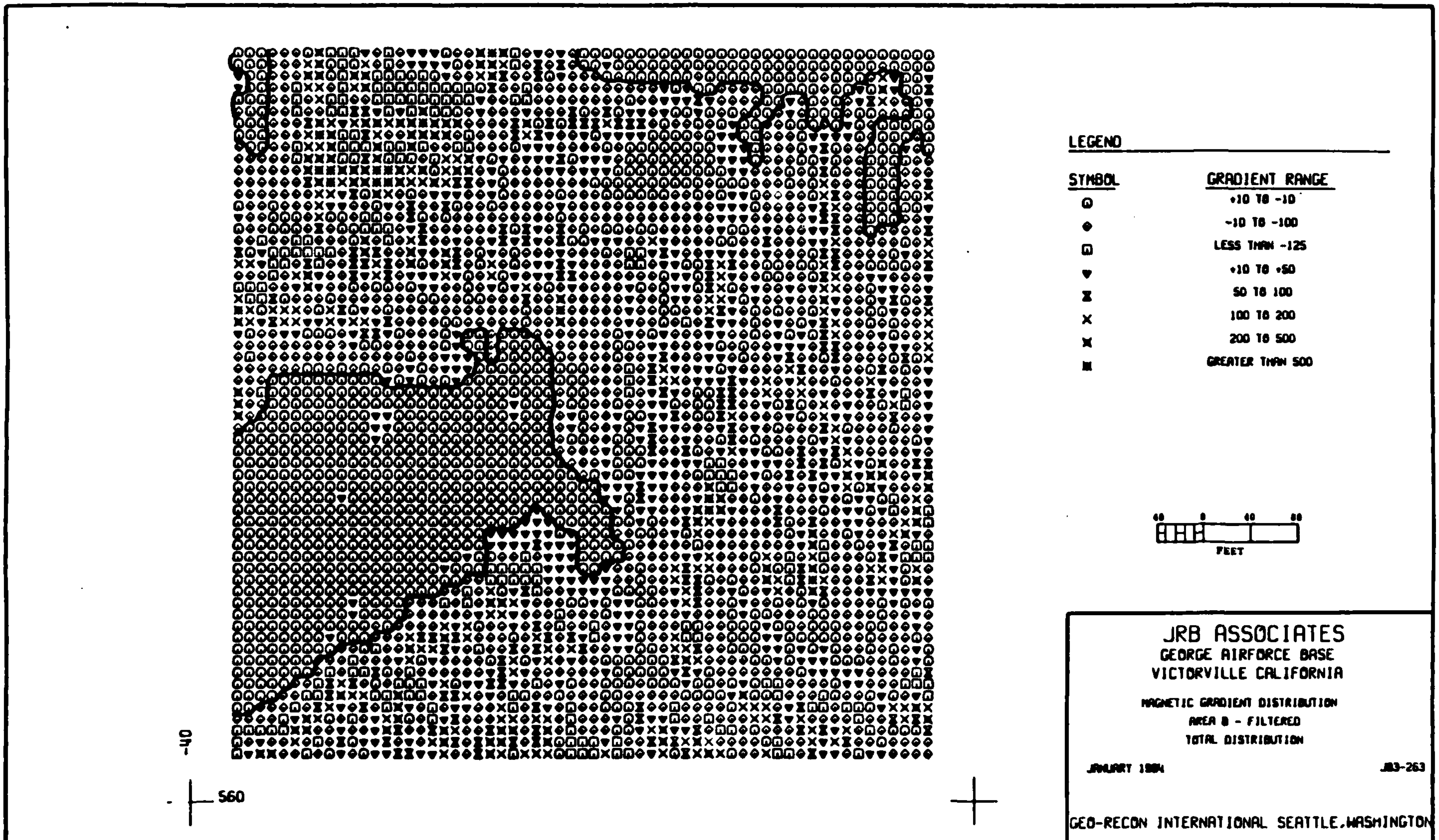


Figure E-4

Area B - Filtered Magnetic Total Gradient Distribution

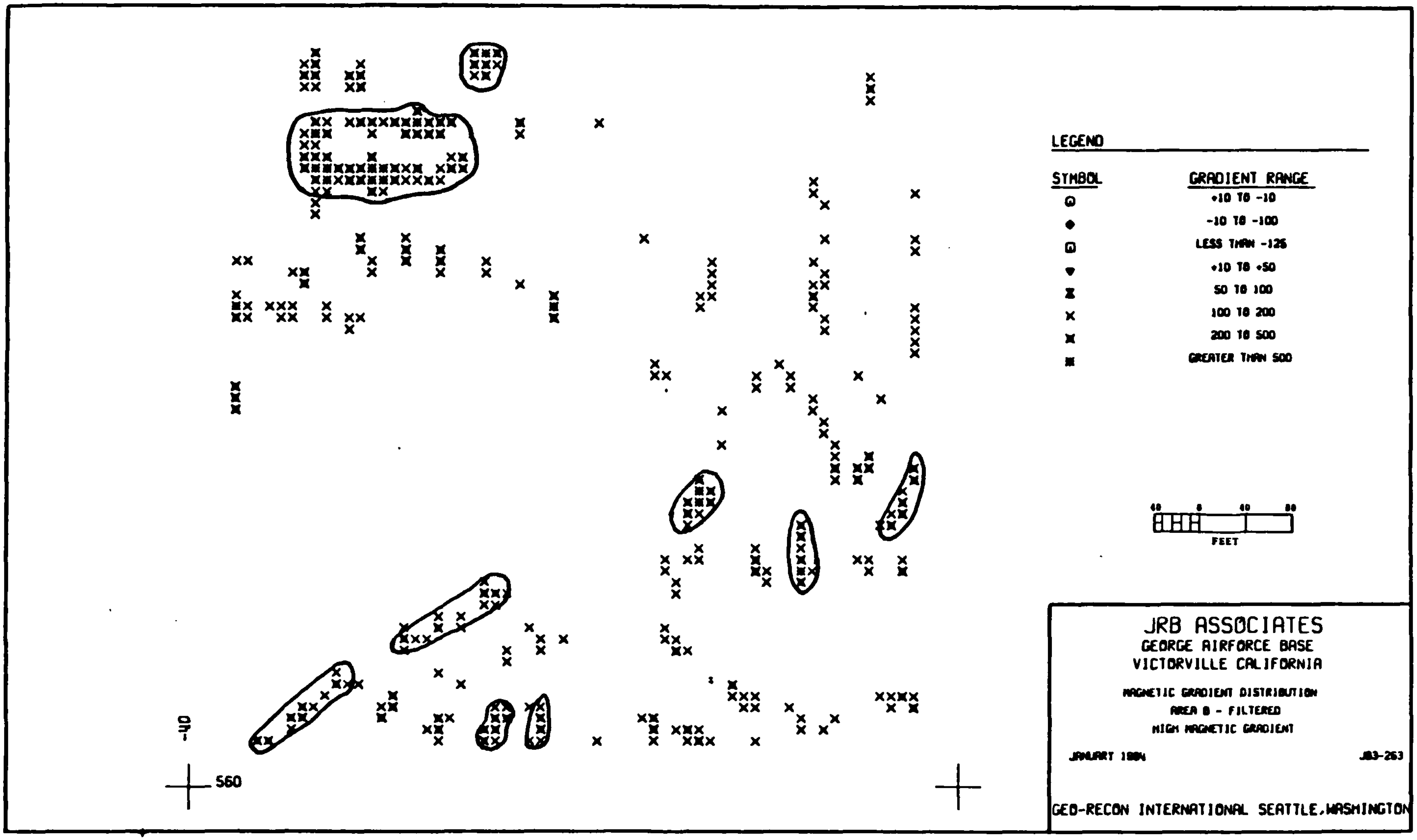


Figure E-5

Area B - Filtered Magnetic High Gradient Distribution

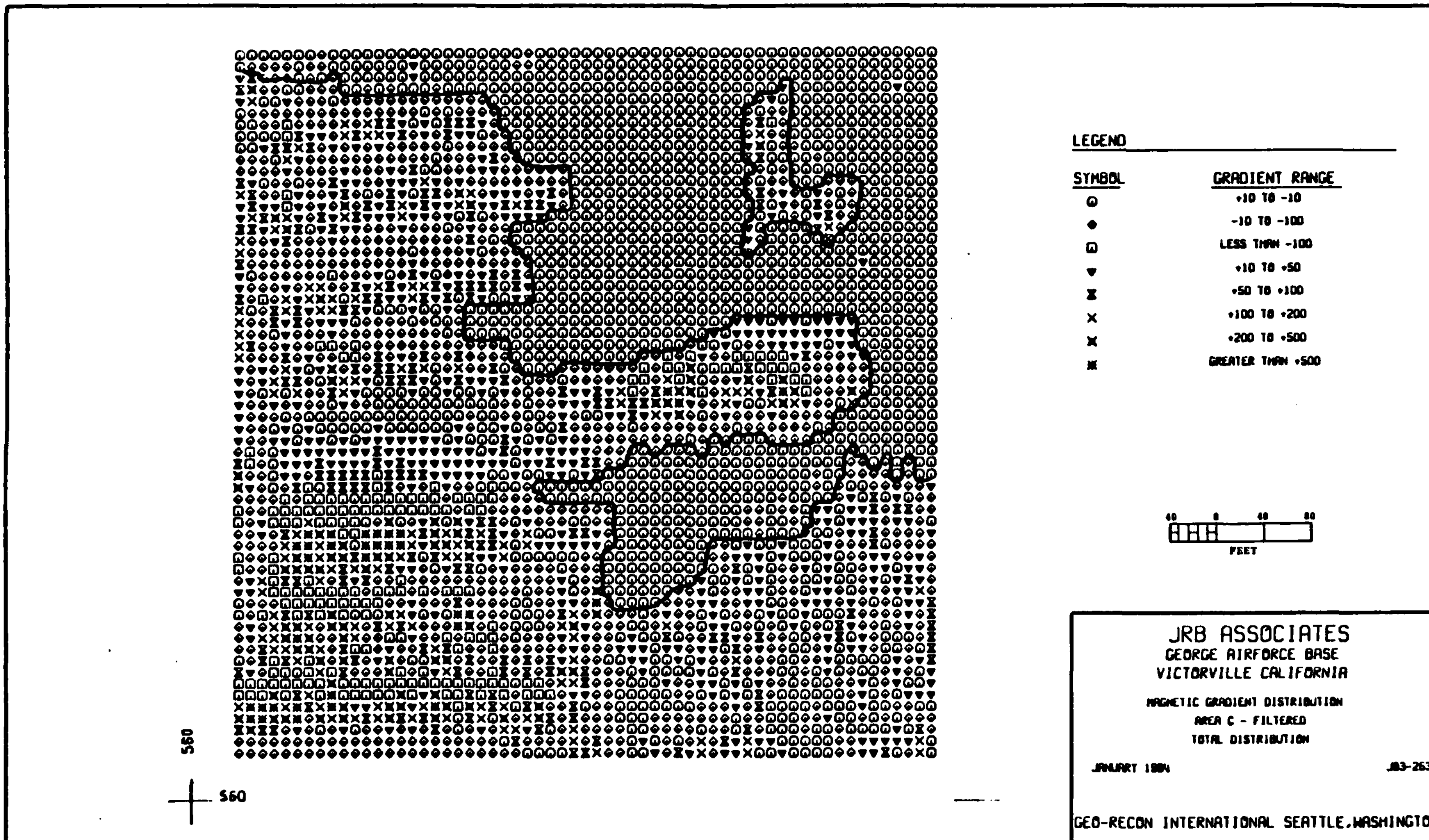


Figure E-6

Area C - Filtered Magnetic Total Gradient Distribution

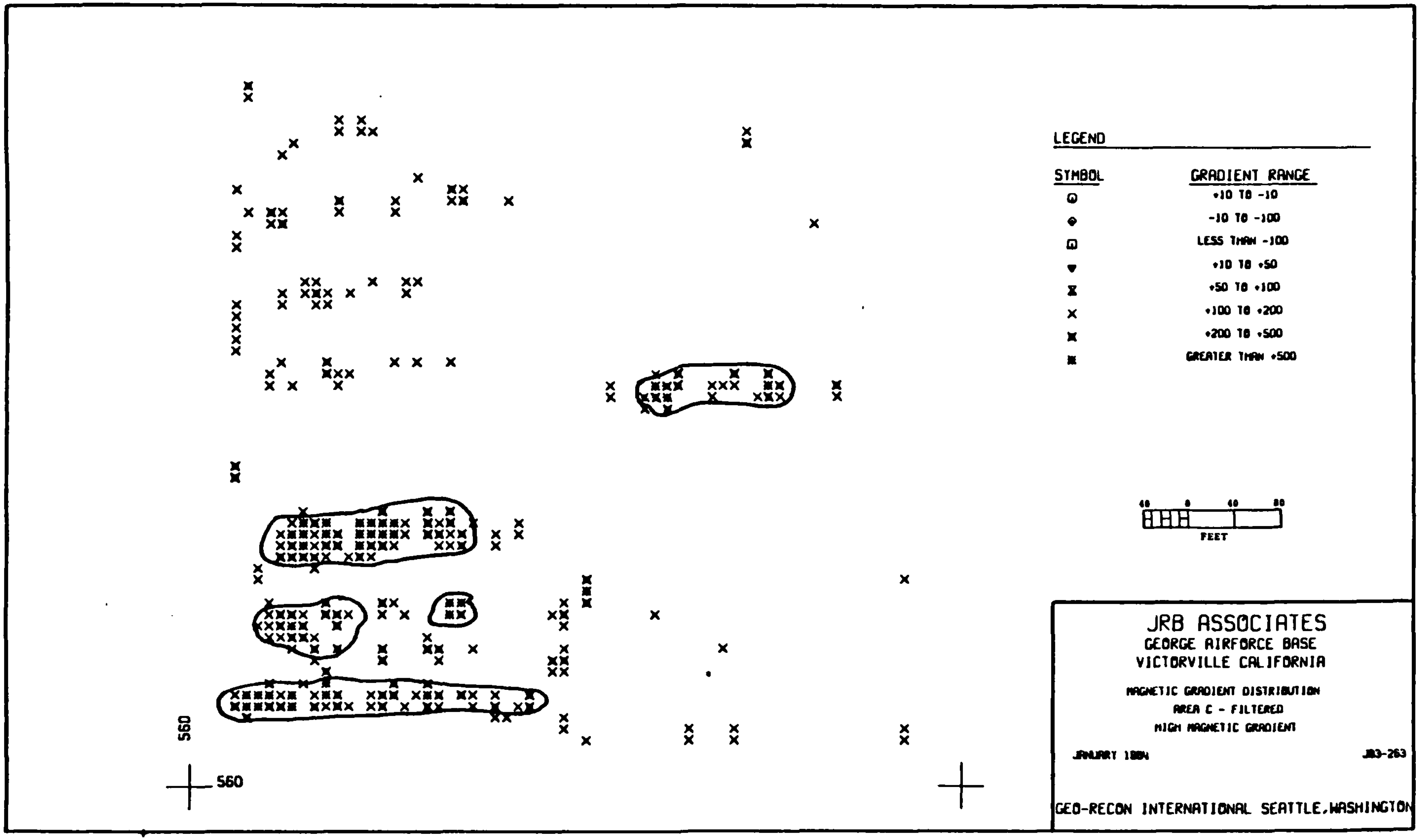


Figure E-7

Area C - Filtered Magnetic High Gradient Distribution

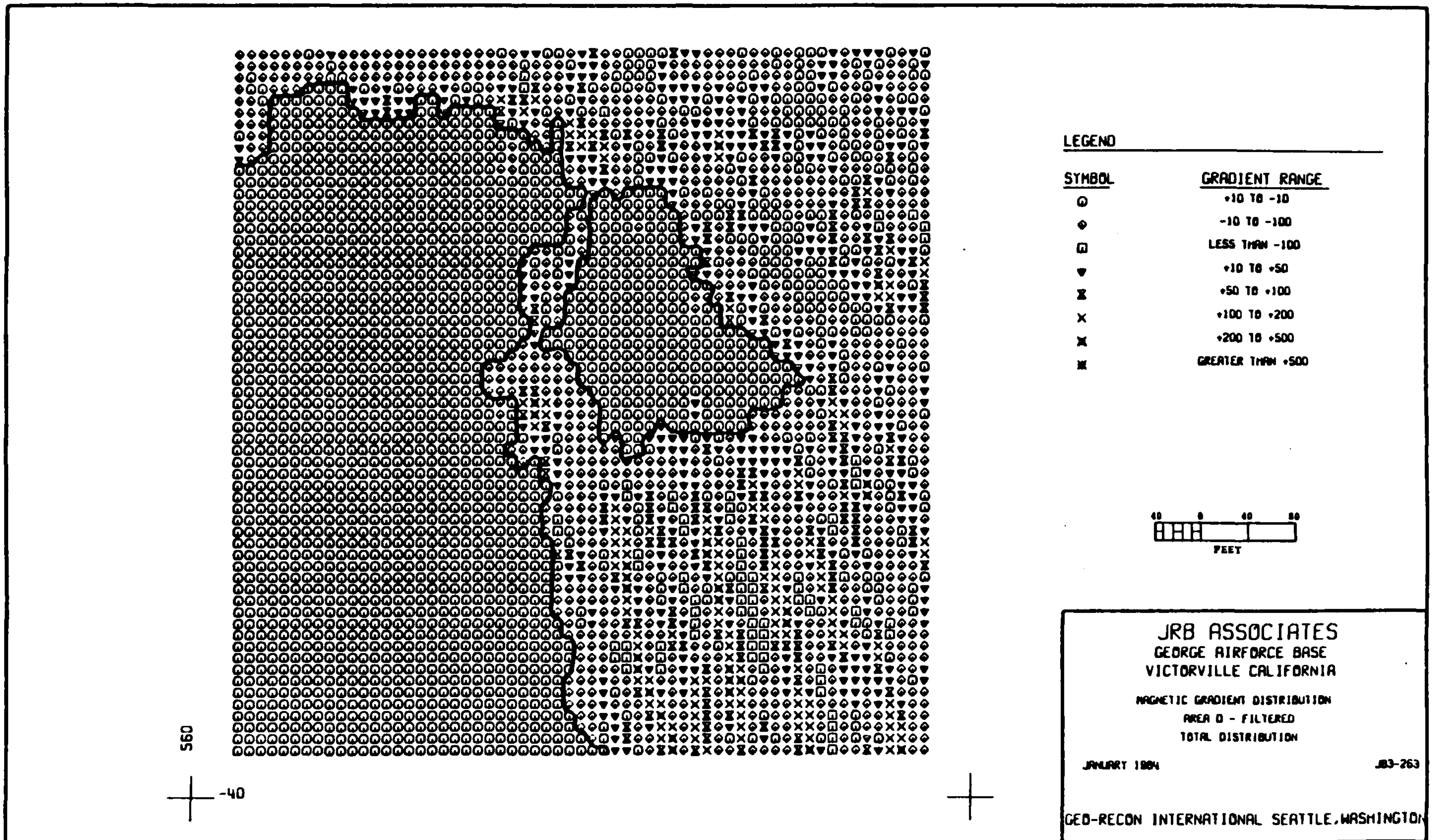


Figure E-8

Area D - Filtered Magnetic Total Gradient Distribution

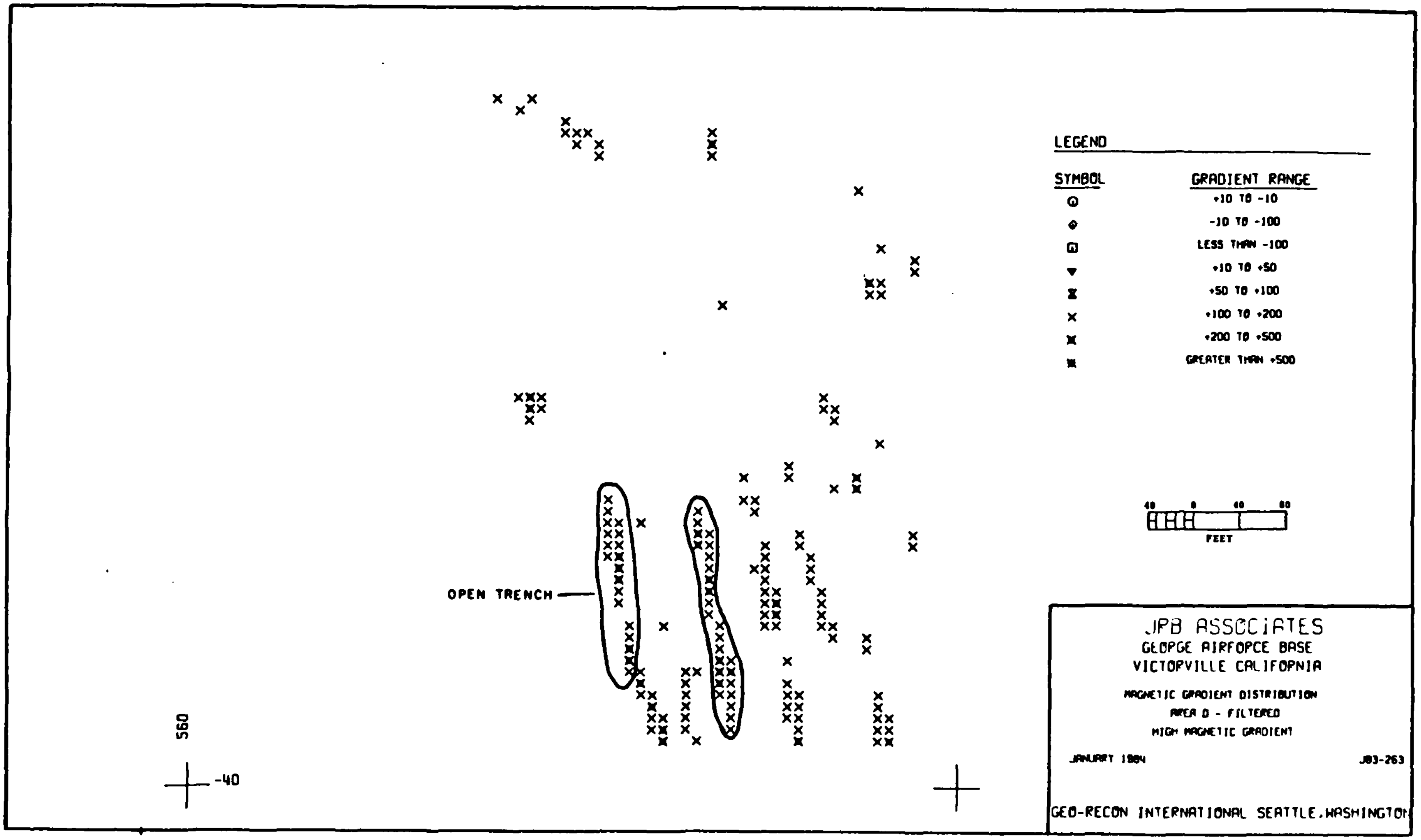


Figure E-9

Area D - Filtered Magnetic High Gradient Distribution

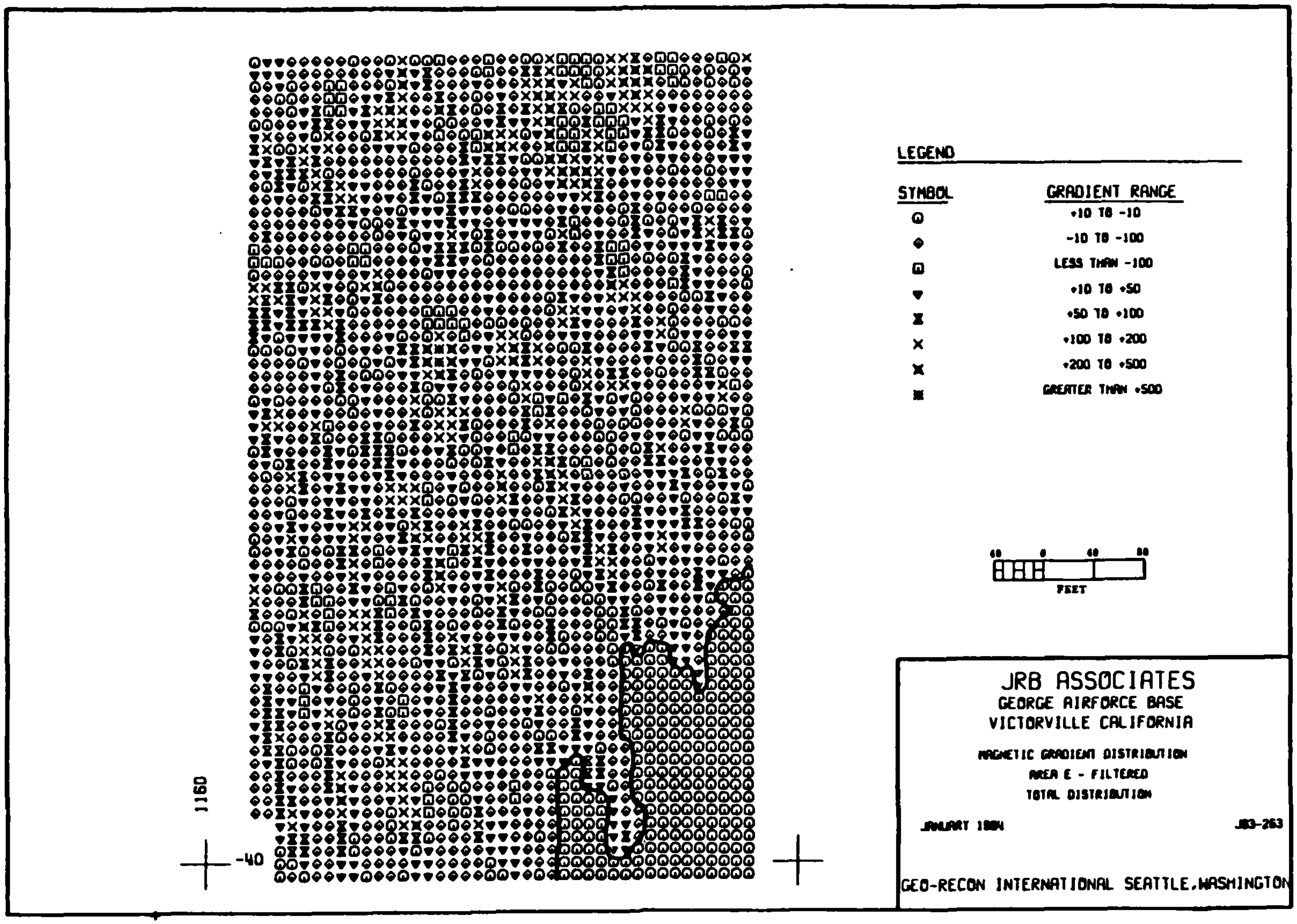


Figure E-10

Area E - Filtered Magnetic Total Gradient Distribution

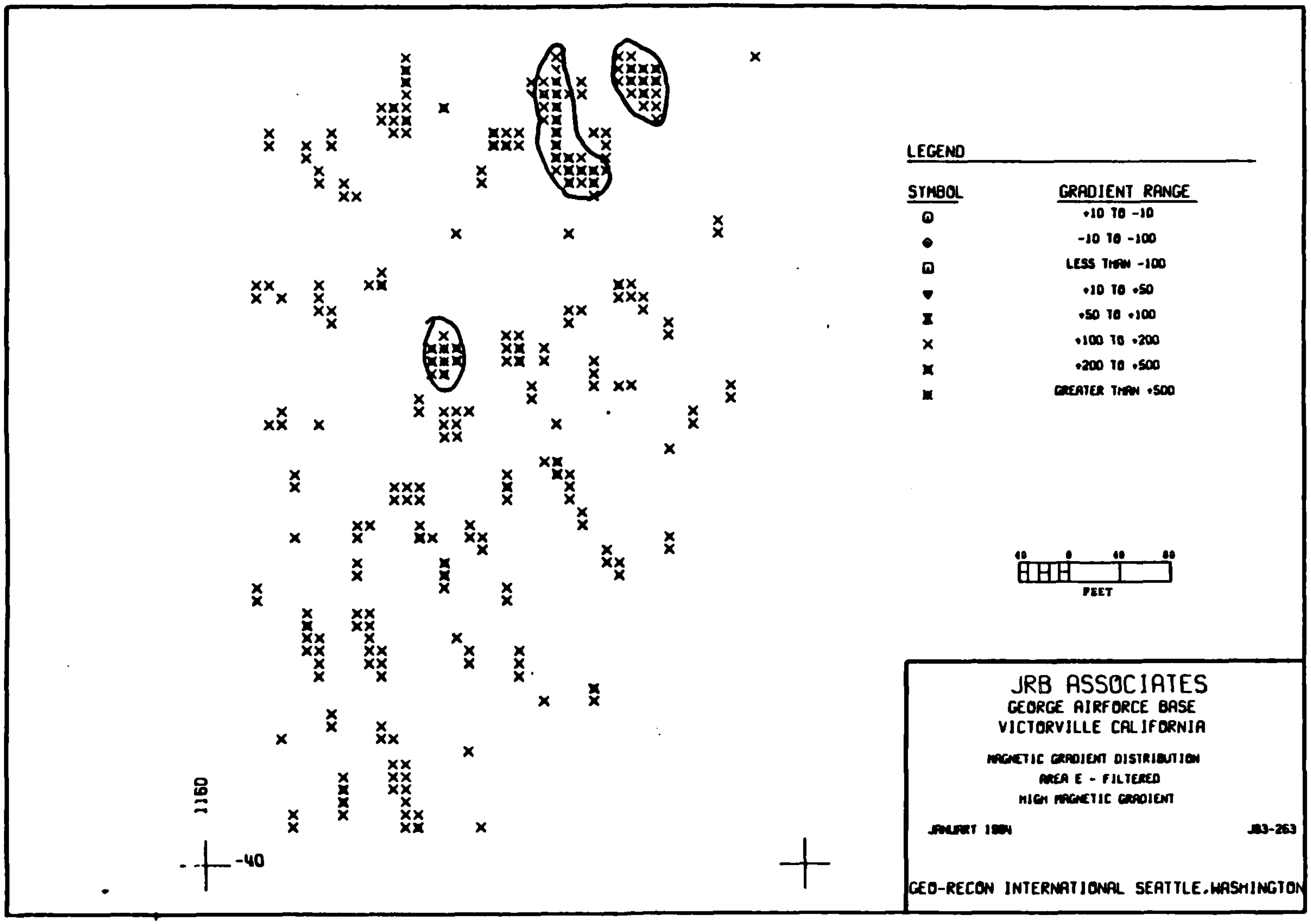


Figure E-11

Area E - Filtered Magnetic High Gradient Distribution

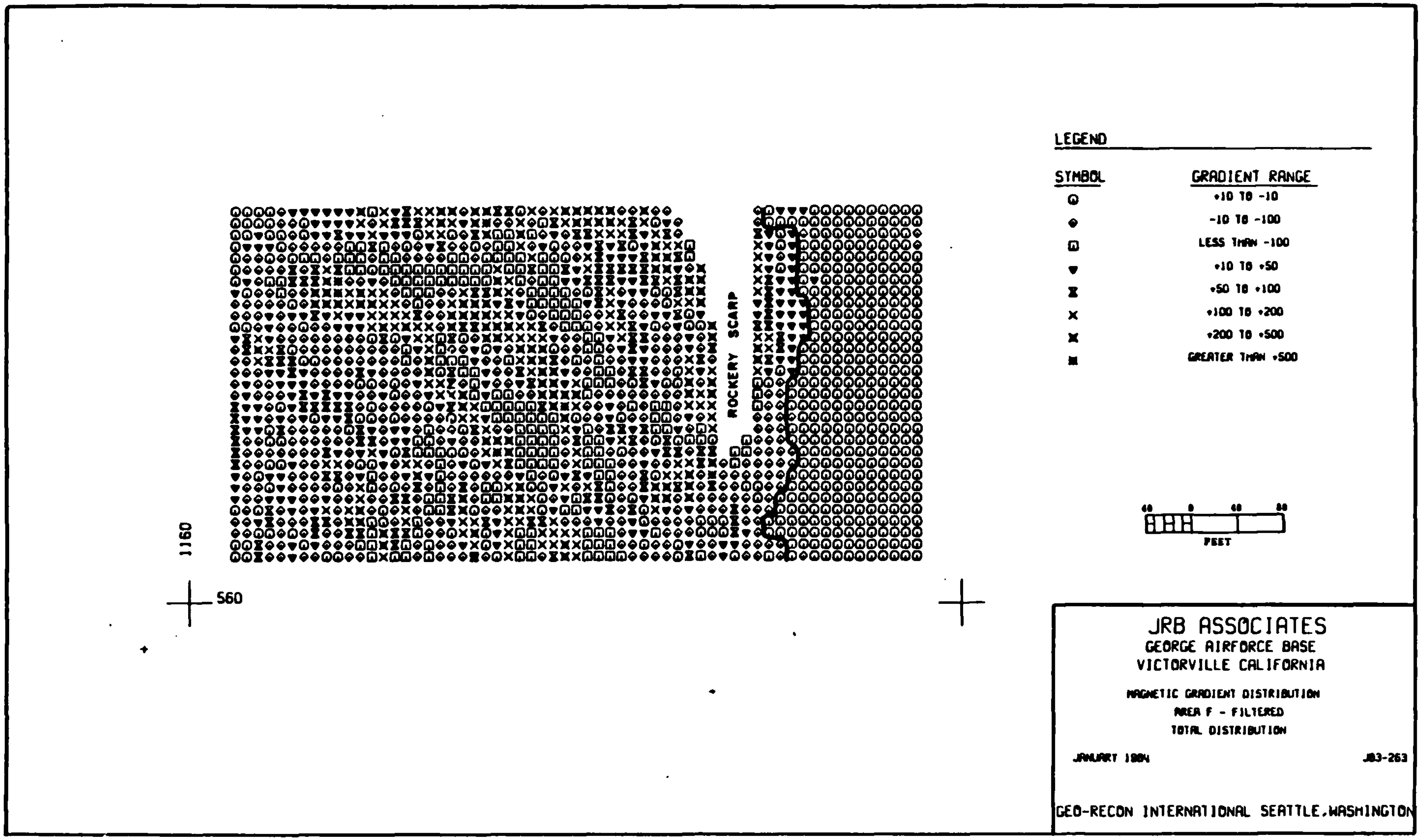


Figure E-12

Area F - Filtered Magnetic Total Gradient Distribution

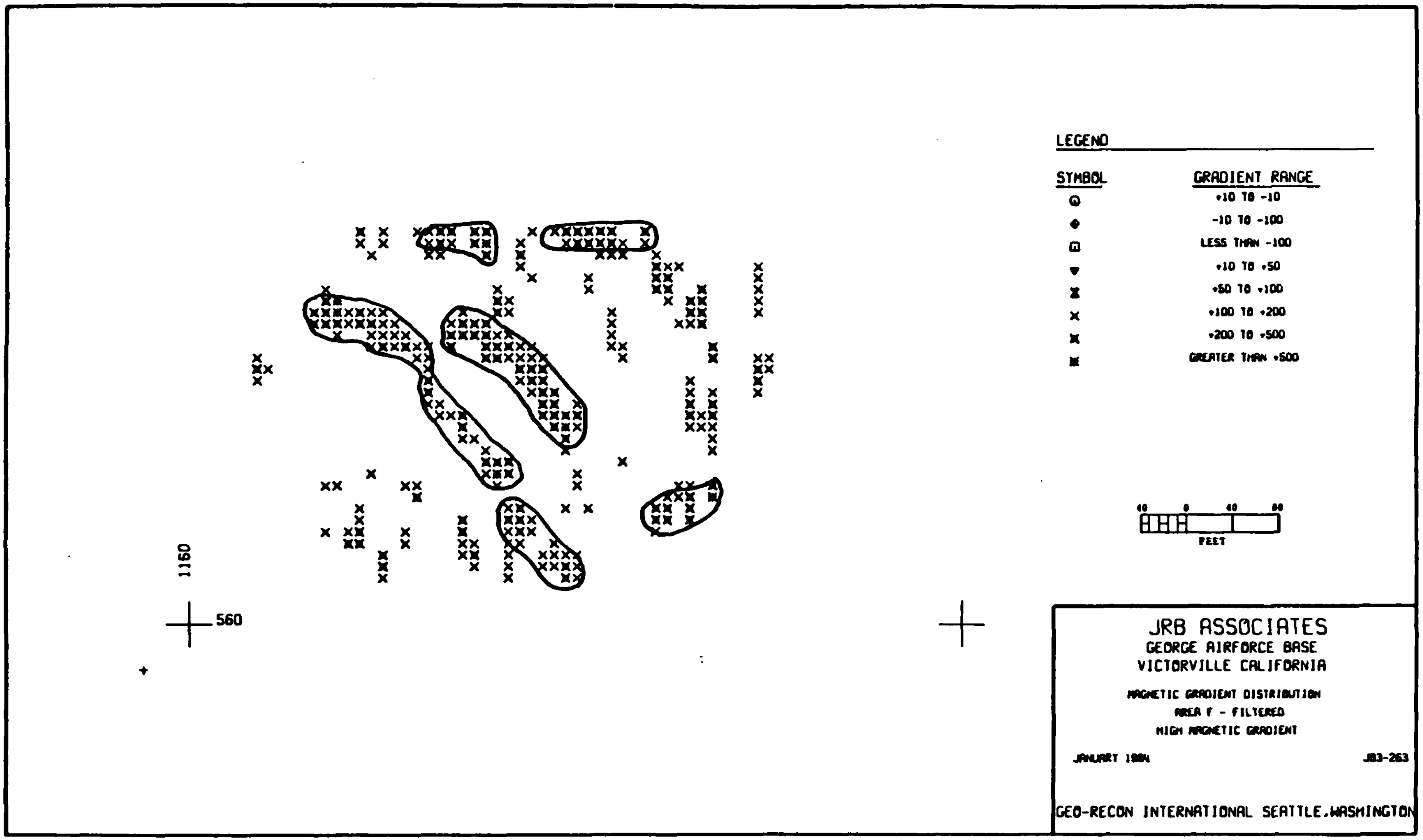


Figure E-13

Area F - Filtered Magnetic High Gradient Distribution

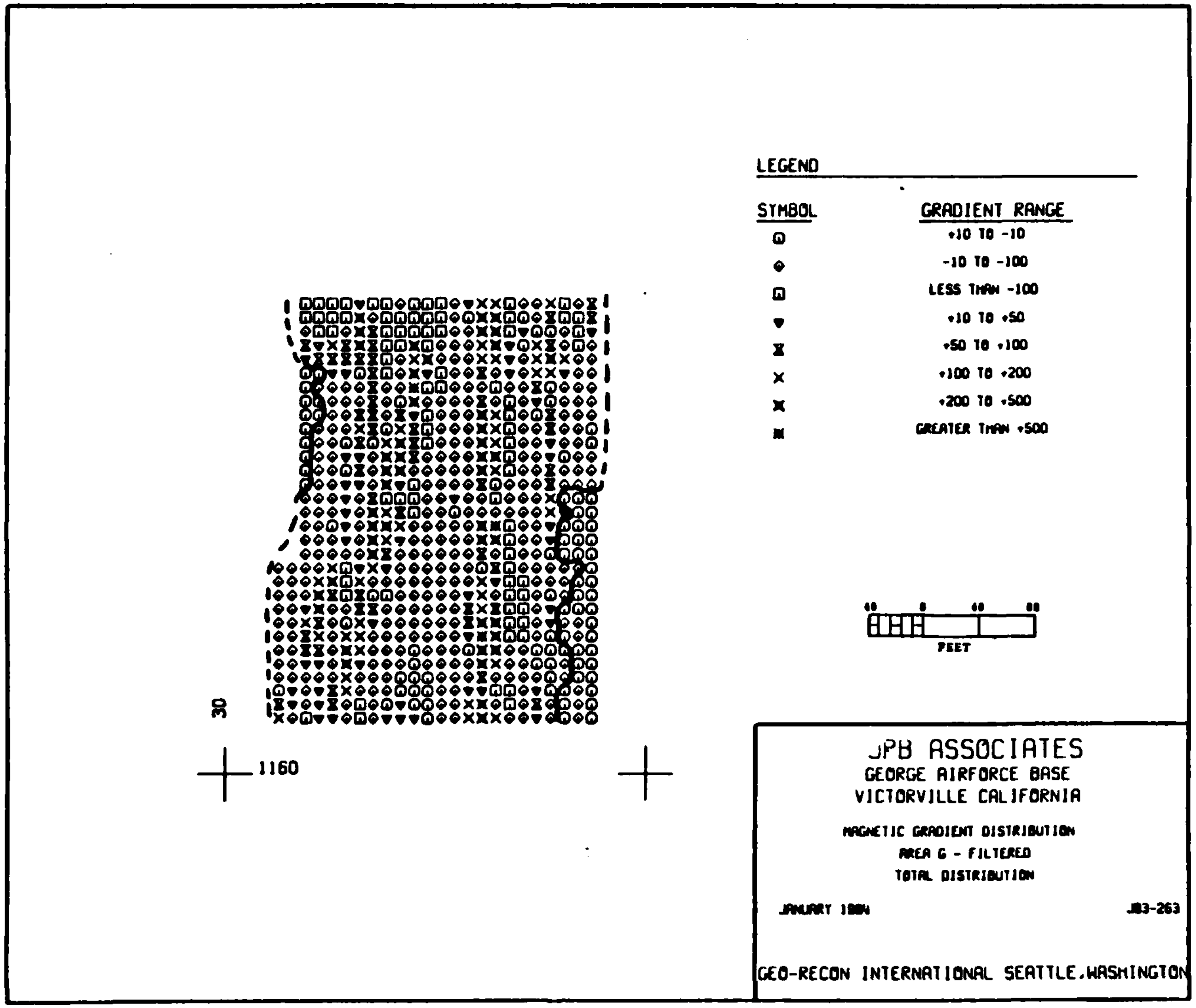


Figure E-14

Area G - Filtered Magnetic Total Gradient Distribution

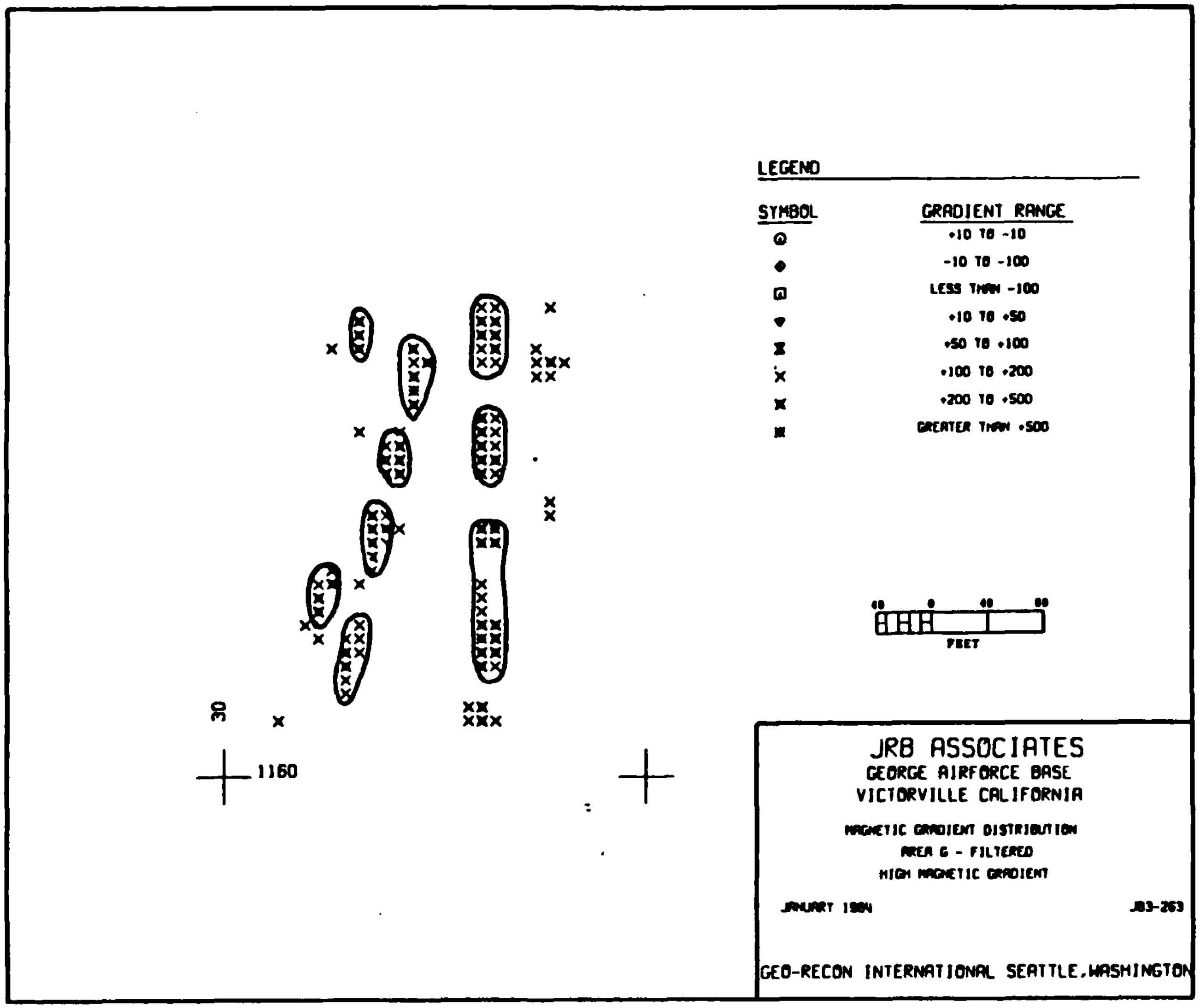


Figure E-15

Area G - Filtered Magnetic High Gradient Distribution

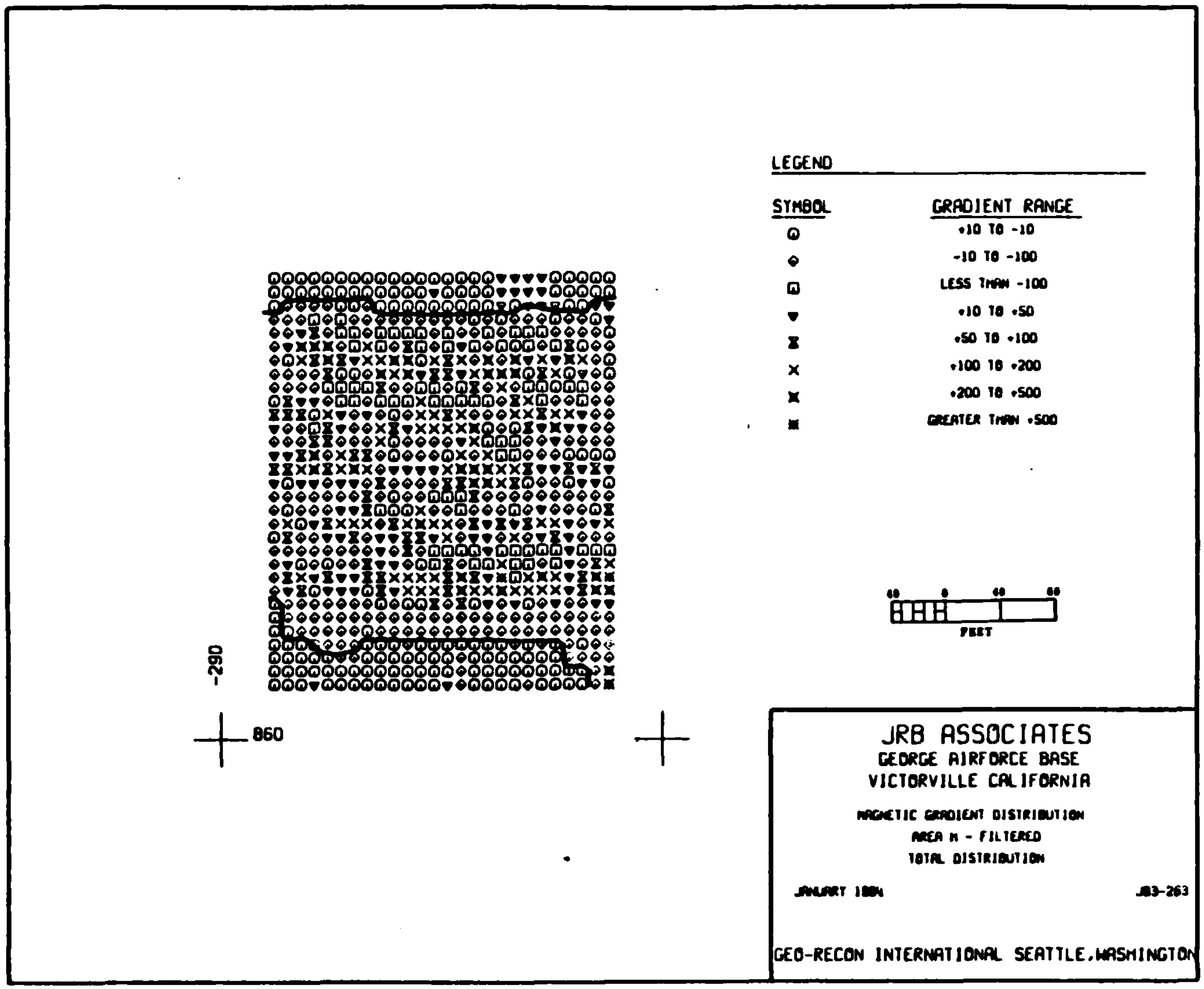


Figure E-16

Area H - Filtered Magnetic Total Gradient Distribution

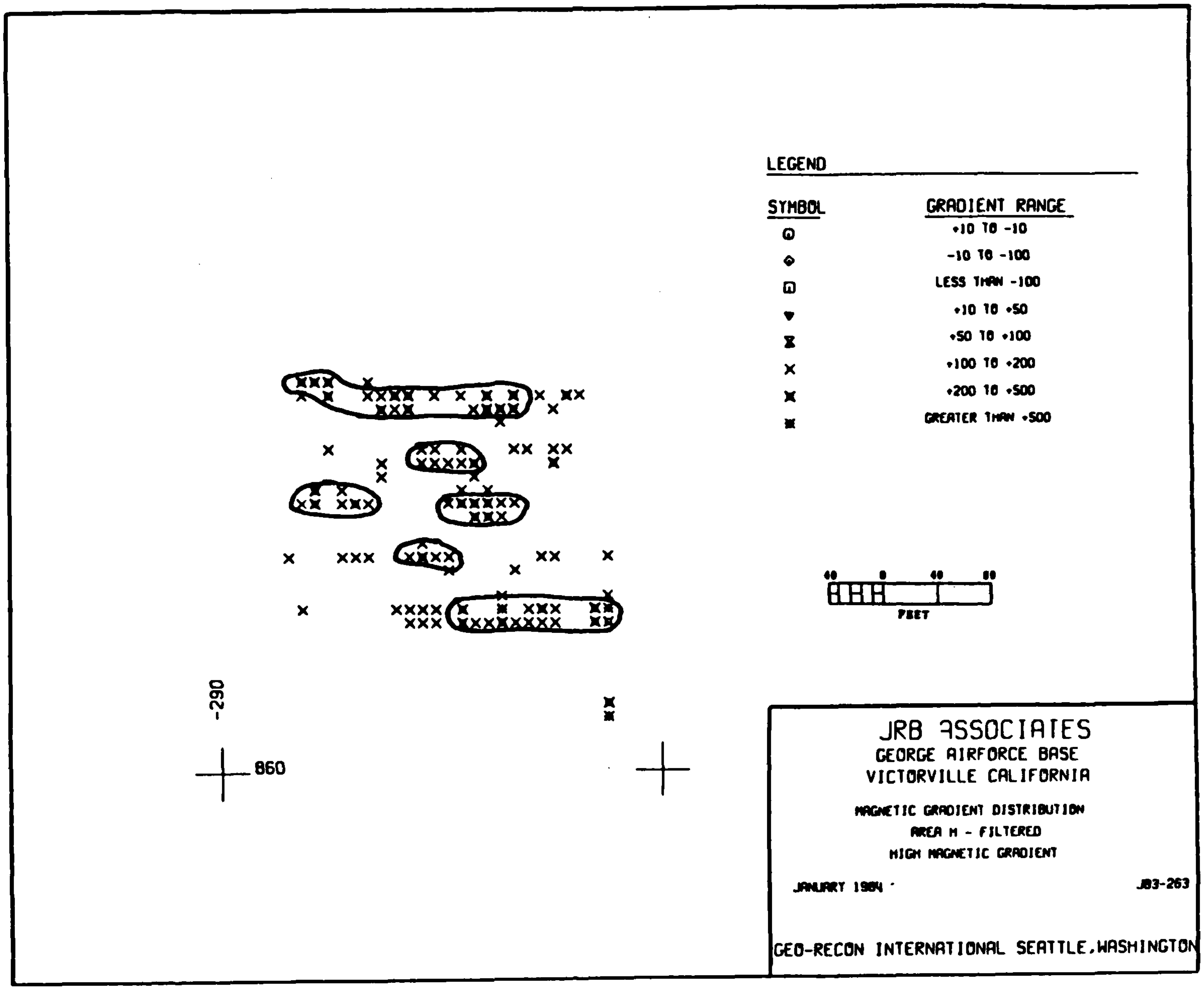


Figure E-17

Area H - Filtered Magnetic High Gradient Distribution.

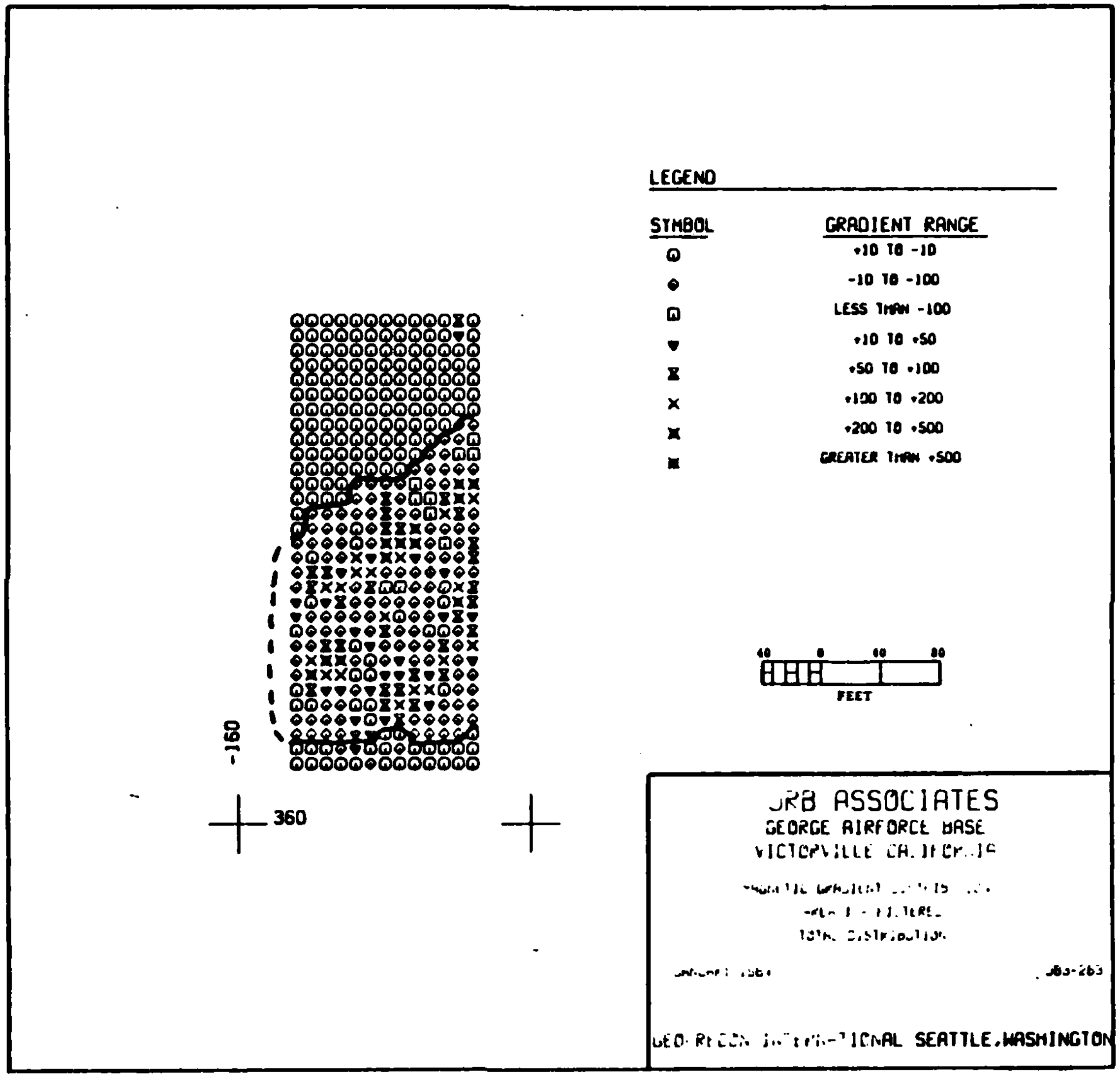


Figure E-18

Area I - Filtered Magnetic Total Gradient Distribution

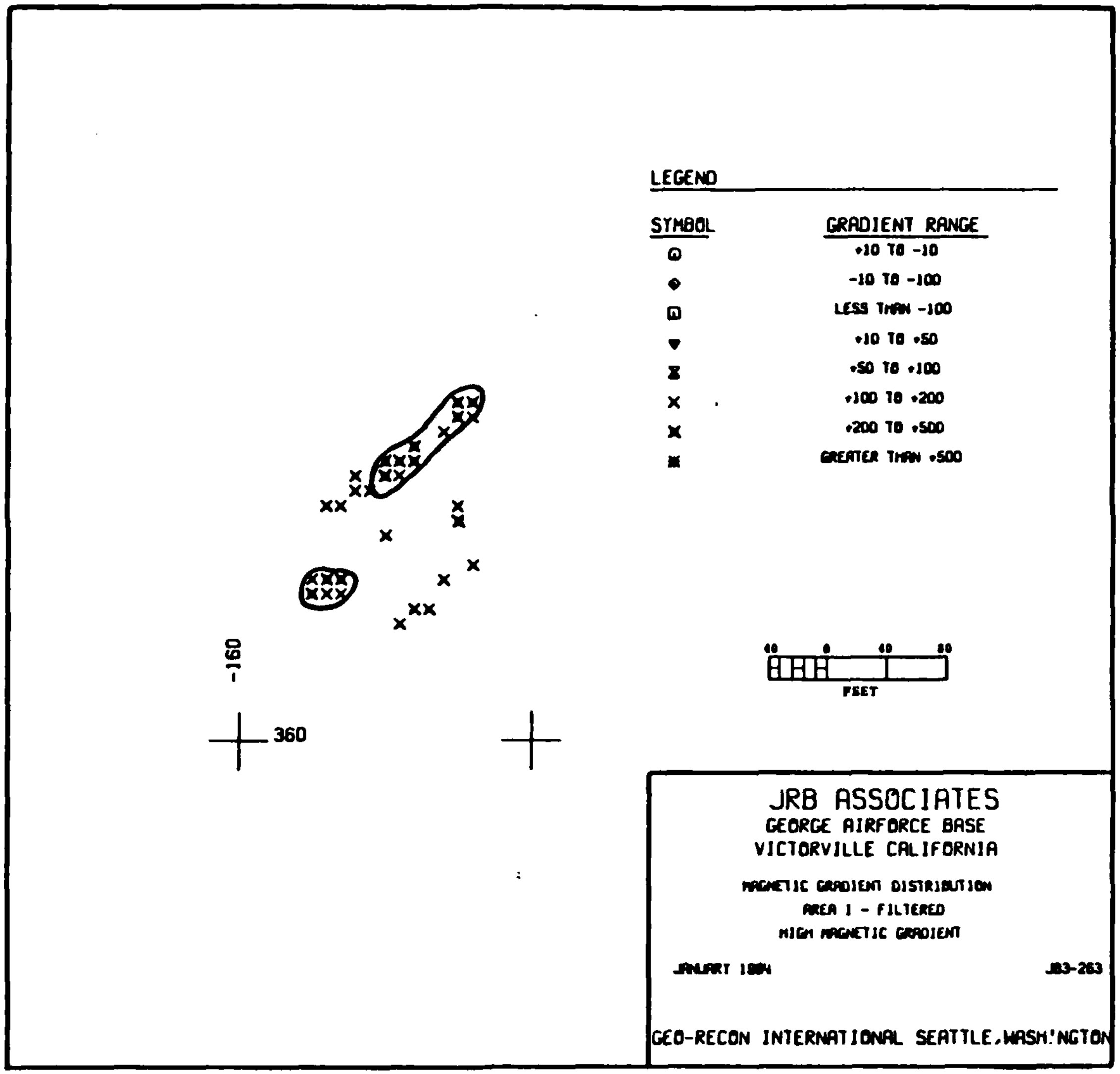


Figure E-19

Area I - Filtered Magnetic High Gradient Distribution

APPENDIX F

CHEMISTRY DATA

QUALITY CONTROL SUMMARY

Submitted To:

JRB Associates, Inc.
8400 Westpark Drive
McLean, VA 22102

Attn: Claudia Wiegand

Project Number:	A1719.1 Reference: JRB-George
Date Sample Received:	February 19, 1984
Date Samples Extracted:	No extraction
Date Samples Analyzed:	February 21, 1984, February 28, 1984
Methodology Employed:	EPA 600 Method for Chemical analysis of water and wastes. Method 413.2 Chemistry Laboratory Manual for Bottom Sediments, U.S. EPA, March 1979, Region V
Sample Quality Control:	ERG's QA/AC requires a duplicate, method spike and blank with each group of samples or with every 10 samples, whichever is larger. The enclosed Quality Control includes this data.

QUALIITY CONTROL SUMMARY

JRB George #A1719.1

SAMPLE NUMBER	PARAMETER	DUPLICATE VALUE*	BLANK VALUE	METHOD SPIKE VALUE	SPIKE LEVEL	% RECOVERY
103418	PCB	ND(0.020)/ND(0.020)mg/Kg	ND(0.020)	0.64	0.50	128
103417	Oil & Grease (I.R.)	92.7/111 mg/Kg	--------	-----	----	-----

*ALL ANALYTICAL RESULTS ARE BLANK SUBTRACTED

erg

ANALYTICAL REPORT

ENVIRONMENTAL RESEARCH GROUP, INC.
117 N. FIRST
ANN ARBOR, MICHIGAN 48104 (313) 662-3104

PROJECT A1719.1
REPORT DATE 03-07-84

CLIENT P.O.: LETTER
REPORT: 5744

SAMPLES RECVD: 02-17-84
REFER TECHNICAL QUESTIONS
TO: JAMES ENDRES

CLIENT:
JRB ASSOCIATES, INC
8400 WESTPARK DRIVE
MC LEAN, VA 22102

APPROVED: James J Bolger

ATTENTION: CLAUDIA WIEGAND

***
RESIDUAL SAMPLES WILL
BE HELD FOR TWO WEEKS
***

CLIENT I.D. 84-6260 CZ01 - 050.5
ERG SAMPLE NO. 02/103417
MATRIX: SOIL
DATE COLLECTED 02-16-84

PARAMETER	RESULTS	UNITS
PCB		
TOTAL PCB	ND (0.020)	mg/Kg
PCB 1242	ND (0.020)	mg/Kg
PCB 1248	ND (0.020)	mg/Kg
PCB 1254	ND (0.020)	mg/Kg
PCB 1260	ND (0.020)	mg/Kg
Percent Moisture	1.3	%
OIL AND GREASE BY IR	100	mg/Kg

CLIENT I.D. 84-6262 CZ01 - 070.5
ERG SAMPLE NO. 02/103418
MATRIX SOIL
DATE COLLECTED 02-16-84

PARAMETER	RESULTS	UNITS
PCB		
TOTAL PCB	ND (0.020)	mg/Kg
PCB 1242	ND (0.020)	mg/Kg
PCB 1248	ND (0.020)	mg/Kg
PCB 1254	ND (0.020)	mg/Kg
PCB 1260	ND (0.020)	mg/Kg
Percent Moisture	12	%
OIL AND GREASE BY IR	89	mg/Kg

CONTINUED

 SEE LAST PAGE FOR EXPLANATION OF SYMBOLS

erg

ANALYTICAL REPORT

ENVIRONMENTAL RESEARCH GROUP, INC.

ERG PROJECT NO. A1719.1 - JRB ASSOCIATES, INC 03-07-84

CLIENT I.D.: 84-E269 CZ01 - 140.5
ERG SAMPLE NO: 02/103419
MATRIX: SOIL
DATE COLLECTED: 02-16-84

PARAMETER	RESULTS	UNITS
PCB		
TOTAL PCB	ND (0.020)	mg/Kg
PCB 1242	ND (0.020)	mg/Kg
PCB 1248	ND (0.020)	mg/Kg
PCB 1254	ND (0.020)	mg/Kg
PCB 1260	ND (0.020)	mg/Kg
Percent Moisture	22	%
OIL AND GREASE BY IR	*	

COMMENTS: INSUFFICIENT SAMPLE

CLIENT I.D.: 85-C052 PR02
ERG SAMPLE NO: 02/103420
MATRIX: SOIL
DATE COLLECTED: 02-16-84

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	100	mg/Kg

FR - SEE FIELD REPORT FOR RESULT
NA - NOT APPLICABLE TO TEST REQUESTED
ND - NONDETECTED, DETECTION LIMIT IN ()
SD - SAMPLE DAMAGED
SR - SEE ATTACHED REPORT FOR RESULT
* - POSITIVE RESULT BUT AT UNQUANTIFIABLE
CONCENTRATION BELOW INDICATED LEVEL

THANK YOU FOR YOUR BUSINESS !

PAGE 2 LAST PAGE

QUALITY CONTROL SUMMARY

Submitted To:	
JRB Associates, Inc. 8400 Westpark Drive McLean, VA 22102	
Attn: Claudia Wiegand	
Project Number:	A1719 JRB-George
Date Sample Received:	February 8, 1984
Date Samples Extracted:	No extraction
Date Samples Analyzed:	March 3, 1984, February 15, 1984, February 20, 1984
Methodology Employed:	Halocarbon Purgeables EPA Method 601
	EPA 600 Method for chemical analysis of water and wastes. Methods 413.2.
	Aromatic Purgeables EPA Method 602.
	Chemistry Laboratory Manual for Bottom Sediments, U.S. EPA, March 1979, Region V.
Sample Quality Control:	ERG's QA/QC requires a duplicate, method spike and blank with each group of samples or with every 10 samples, whichever is larger.
	The enclosed Quality Control Summary includes this data.

QUALITY CONTROL SUMMARY

SAMPLE NUMBER	PARAMETER	DUPLICATE VALUE[a]	BLANK VALUE	SPIKE LEVEL	METHOD SPIKE VALUE	% RECOVERY
102584	p,p'-DDE	ND(0.020)/ND(0.020) mg/kg	ND(0.020)	0.04 mg/kg	0.022	55
102584	p,p'-DDD	ND(0.020)/ND(0.020) mg/kg	ND(0.020)	0.04 mg/kg	0.022	55
102584	p,p'-DDT	ND(0.020)/ND(0.020) mg/kg	ND(0.020)	0.04 mg/kg	0.022	55
102584	Chlordane	ND(0.020)/ND(0.020) mg/kg	ND(0.020)	----------	-----	--
102573	Percent Moisture	5.41/6.67%	0.016	----------	-----	--
102577	Percent Moisture	7.22/5.95%	0.016	----------	-----	--
102571	Oil & Grease-I.R.	91.67/212.0[b]	--------	----------	-----	--
102572	Chromium	3.15/1.50[b]	0.011	1 ppm	0.92	92
102572	Lead	1.94/<3[b]	0.001	2 ppm	1.99	99.5
102579	Lead	0.49/<3[b]	0.001	2 ppm	1.99	99.5
102572	Silver	ND(0.8/ND(0.8)	0.001	2 ppm	1.84	92
102579	Silver	0.246/ND(0.8)	0.001	2 ppm	1.84	92
102576	Haloscan:Br	ND(0.1)/ND(0.1)	0	5 ppb	5.1	102
102578	Haloscan:Br	ND(0.1)/ND(0.1)	0	5 ppb	5.23	102
102576	Haloscan:Cl	ND(0.5)/ND(0.5)	0	50 ppb	47.6	95
102579	Haloscan:Cl	ND(0.5)/ND(0.5)	0	50 ppb	44.8	90
102576	Haloscan:I	ND(0.5)/ND(0.5)	0	5 ppb	4.78	96
102579	Haloscan:I	ND(0.05)/ND(0.05)	0	5 ppb	5.04	100
102578	Phenols	ND(0.22)/ND(0.22) mg/kg	0.002	66 ppb	0.064	95

[a]All analytical results are blank subtracted.

[b]No apparent sample preparation or analytical error to cause widely variable results.

ANALYTICAL REPORT

erg™
ENVIRONMENTAL RESEARCH GROUP, INC.
117 N. FIRST
ANN ARBOR, MICHIGAN 48104 (313) 662-3104

PROJECT A1719
REPORT DATE 03-13-84

CLIENT P.O.: LETTER
REPORT: 5916

SAMPLES RECVD. 02-08-84
REFER TECHNICAL QUESTIONS
TO: JACK SHEETS

CLIENT:
URS ASSOCIATES, INC
8400 WESTPARK DRIVE
MC LEAN, VA 22102

APPROVED: James J Bolger

ATTENTION: CLAUDIA NIEDANO

RESIDUAL SAMPLES WILL
BE HELD FOR TWO WEEKS

CLIENT I.D. 85-0001 PR01
ERG SAMPLE NO 02/102571
MATRIX SEDIMENT
DATE COLLECTED 02-06-84

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	150	mg/Kg
PERCENT MOISTURE	10	%

CLIENT I.D. 85-0002 ID01
ERG SAMPLE NO 02/102572
MATRIX SEDIMENT
DATE COLLECTED [illegible]-84

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	200	mg/Kg
PHENOLS	0.2	mg/Kg
CHROMIUM, TOTAL	2	mg/Kg
LEAD, TOTAL	13	mg/Kg
SILVER, TOTAL	ND (0.2)	mg/Kg
HALOGEN - E		
ORGANIC CHLORIDE	ND (0.5)	mg/Kg
ORGANIC BROMIDE	ND (0.1)	mg/Kg
ORGANIC IODIDE	ND (0.05)	mg/Kg
CHLORDANE	ND (0.020)	mg/Kg
PERCENT MOISTURE	3	%
DDT, P,P'-	ND (0.020)	mg/Kg
DDE, P,P'-	ND (0.020)	mg/Kg
DDD, P,P'-	ND (0.020)	mg/Kg

CONTINUED

 SEE LAST PAGE FOR EXPLANATION OF SYMBOLS

ANALYTICAL REPORT

ENVIRONMENTAL RESEARCH GROUP, INC.

ERG PROJECT NO. A1719 - JRB ASSOCIATES, INC 03-13-84

CLIENT I.D.: 85-0004 ID02
ERG SAMPLE NO: 02/102573
MATRIX: SEDIMENT
DATE COLLECTED: 02-06-84

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	140	mg/Kg
PHENOLS	0.2	mg/Kg
CHROMIUM, TOTAL	10	mg/Kg
LEAD, TOTAL	<3	mg/Kg
SILVER, TOTAL	ND (0.8)	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	ND (0.5)	mg/Kg
ORGANIC BROMIDE	ND (0.1)	mg/Kg
ORGANIC IODIDE	ND (0.05)	mg/Kg
CHLORDANE	ND (0.020)	mg/Kg
PERCENT MOISTURE	6	%
DDT, p,p'-	ND (0.020)	mg/Kg
DDE, p,p'-	ND (0.020)	mg/Kg
DDD, p,p'-	ND (0.020)	mg/Kg

CLIENT I.D.: 85-0005 ID03
ERG SAMPLE NO: 02/102574
MATRIX: SEDIMENT
DATE COLLECTED: 02-06-84

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	120	mg/Kg
PHENOLS	ND (0.2)	mg/Kg
CHROMIUM, TOTAL	6	mg/Kg
LEAD, TOTAL	<3	mg/Kg
SILVER, TOTAL	ND (0.8)	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	ND (0.5)	mg/Kg
ORGANIC BROMIDE	ND (0.1)	mg/Kg
ORGANIC IODIDE	ND (0.05)	mg/Kg
CHLORDANE	ND (0.020)	mg/Kg
PERCENT MOISTURE	6	%
DDT, p,p'-	ND (0.020)	mg/Kg
DDE, p,p'-	ND (0.020)	mg/Kg
DDD, p,p'-	ND (0.020)	mg/Kg

CONTINUED

 SEE LAST PAGE FOR EXPLANATION OF SYMBOLS

ANALYTICAL REPORT

ENVIRONMENTAL RESEARCH GROUP, INC.

ERG PROJECT NO. A1719 - JRB ASSOCIATES, INC 03-13-84

CLIENT I.D.: 85-0306 ID04
ERG SAMPLE NO: 02/102575
MATRIX: SEDIMENT
DATE COLLECTED: 02-06-84

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	180	mg/Kg
PHENOLS	ND (0.2)	mg/kg
CHROMIUM, TOTAL	9	mg/Kg
LEAD, TOTAL	<3	mg/Kg
SILVER, TOTAL	ND (0.8)	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	ND (0.5)	mg/Kg
ORGANIC BROMIDE	ND (0.1)	mg/Kg
ORGANIC IODIDE	ND (0.05)	mg/Kg
CHLORDANE	ND (0.020)	mg/Kg
PERCENT MOISTURE	9	%
DDT, p,p'-	ND (0.020)	mg/Kg
DDE, p,p'-	ND (0.020)	mg/Kg
DDD, p,p'-	ND (0.020)	mg/Kg

CLIENT I.D.: [illegible] ID05
ERG SAMPLE NO: [illegible]
MATRIX: [illegible]
DATE COLLECTED: [illegible]

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	170	mg/Kg
PHENOLS	ND (0.2)	mg/kg
CHROMIUM, TOTAL	3	mg/Kg
LEAD, TOTAL	ND (3)	mg/Kg
SILVER, TOTAL	ND (0.8)	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	ND (0.5)	mg/Kg
ORGANIC BROMIDE	ND (0.1)	mg/Kg
ORGANIC IODIDE	ND (0.05)	mg/Kg
CHLORDANE	ND (0.020)	mg/Kg
PERCENT MOISTURE	3	%
DDT, p,p'-	ND (0.020)	mg/Kg
DDE, p,p'-	ND (0.020)	mg/Kg
DDD, p,p'-	ND (0.020)	mg/Kg

CONTINUED

 SEE LAST PAGE FOR EXPLANATION OF SYMBOLS

ANALYTICAL REPORT

ENVIRONMENTAL RESEARCH GROUP, INC.

ERG PROJECT NO. A1719 - JRB ASSOCIATES, INC 03-13-84

CLIENT I.D.: 85-0008 ID06
ERG SAMPLE NO: 02/102577
MATRIX: SEDIMENT
DATE COLLECTED: 02-06-84

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	90	mg/Kg
PHENOLS	0.4	mg/Kg
CHROMIUM, TOTAL	11	mg/Kg
LEAD, TOTAL	<3	mg/Kg
SILVER, TOTAL	ND (0.8)	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	ND (0.5)	mg/Kg
ORGANIC BROMIDE	ND (0.1)	mg/Kg
ORGANIC IODIDE	ND (0.05)	mg/Kg
CHLORDANE	ND (0.020)	mg/Kg
PERCENT MOISTURE	7	%
DDT, p,p'-	ND (0.020)	mg/Kg
DDE, p,p'-	ND (0.020)	mg/Kg
DDD, p,p'-	ND (0.020)	mg/Kg

CLIENT I.D. 85-0009 ID07
ERG SAMPLE NO: 02/102578
MATRIX: SEDIMENT
DATE COLLECTED: 02-06-84

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	250	mg/Kg
PHENOLS	ND (0.2)	mg/Kg
CHROMIUM, TOTAL	9	mg/Kg
LEAD, TOTAL	4	mg/Kg
SILVER, TOTAL	ND (0.8)	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	ND (0.5)	mg/Kg
ORGANIC BROMIDE	ND (0.1)	mg/Kg
ORGANIC IODIDE	ND (0.05)	mg/Kg
CHLORDANE	ND (0.020)	mg/Kg
PERCENT MOISTURE	4	%
DDT, p,p'-	ND (0.020)	mg/Kg
DDE, p,p'-	ND (0.020)	mg/Kg
DDD, p,p'-	ND (0.020)	mg/Kg

 SEE LAST PAGE FOR EXPLANATION OF SYMBOLS

CONTINUED

ANALYTICAL REPORT

ENVIRONMENTAL RESEARCH GROUP, INC.

ERG PROJECT NO. A1719 - JRB ASSOCIATES, INC 03-13-84

CLIENT I.D.: 85-0015 SZ02 - 055
ERG SAMPLE NO: 02/102579
MATRIX: SEDIMENT
DATE COLLECTED: 02-06-84

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	100	mg/Kg
PHENOLS	0.23	mg/Kg
CHROMIUM, TOTAL	20	mg/Kg
LEAD, TOTAL	<3	mg/Kg
SILVER, TOTAL	<0.8	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	ND (0.5)	mg/Kg
ORGANIC BROMIDE	ND (0.1)	mg/Kg
ORGANIC IODIDE	ND (0.05)	mg/Kg
CHLORDANE	ND (0.020)	mg/Kg
PERCENT MOISTURE	35	%
DDT, p,p'-	ND (0.020)	mg/Kg
DDE, p,p'-	ND (0.020)	mg/Kg
DDD, p,p'-	ND (0.020)	mg/Kg

CLIENT I.D.: 85-0017 SZ02 - 075
ERG SAMPLE NO: 02/102580
MATRIX: SEDIMENT
DATE COLLECTED: 02-06-84

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	96	mg/Kg
PHENOLS	ND (0.3)	mg/Kg
CHROMIUM, TOTAL	34	mg/Kg
LEAD, TOTAL	8	mg/Kg
SILVER, TOTAL	ND (0.8)	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	ND (0.5)	mg/Kg
ORGANIC BROMIDE	ND (0.1)	mg/Kg
ORGANIC IODIDE	ND (0.05)	mg/Kg
CHLORDANE	ND (0.020)	mg/Kg
PERCENT MOISTURE	22	%
DDT, p,p'-	ND (0.020)	mg/Kg
DDE, p,p'-	ND (0.020)	mg/Kg
DDD, p,p'-	ND (0.020)	mg/Kg

 SEE LAST PAGE FOR EXPLANATION OF SYMBOLS

CONTINUED

ANALYTICAL REPORT

ENVIRONMENTAL RESEARCH GROUP, INC.

ERG PROJECT NO. A1719 - JRB ASSOCIATES, INC 03-13-84

CLIENT I.D.: 85-0019 SZ02 - 095
ERG SAMPLE NO: 02/102581
MATRIX: SEDIMENT
DATE COLLECTED: 02-06-84

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	*	
COMMENTS: INSUFFICIENT SAMPLE		
PHENOLS	ND (0.2)	mg/kg
CHROMIUM, TOTAL	11	mg/Kg
LEAD, TOTAL	<3	mg/Kg
SILVER, TOTAL	ND (0.8)	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	ND (0.5)	mg/Kg
ORGANIC BROMIDE	ND (0.1)	mg/Kg
ORGANIC IODIDE	ND (0.05)	mg/Kg
CHLORDANE	ND (0.020)	mg/Kg
PERCENT MOISTURE	16	%
DDT, p,p'-	ND (0.020)	mg/Kg
DDE, p,p'-	ND (0.020)	mg/Kg
DDD, p,p'-	ND (0.020)	mg/Kg

CLIENT I.D. 85-0028 NZ05 - 086.0
ERG SAMPLE NO: [illegible]
MATRIX: SEDIMENT
DATE COLLECTED: [illegible]

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	140	mg/Kg
PHENOLS	ND (0.4)	mg/Kg
CHROMIUM, TOTAL	19	mg/Kg
LEAD, TOTAL	<3	mg/Kg
SILVER, TOTAL	ND (0.8)	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	ND (0.5)	mg/Kg
ORGANIC BROMIDE	ND (0.1)	mg/Kg
ORGANIC IODIDE	ND (0.05)	mg/Kg
CHLORDANE	ND (0.020)	mg/Kg
PERCENT MOISTURE	17	%
DDT, p,p'-	ND (0.020)	mg/Kg
DDE, p,p'-	ND (0.020)	mg/Kg
DDD, p,p'-	ND (0.020)	mg/Kg

CONTINUED

 SEE LAST PAGE FOR EXPLANATION OF SYMBOLS

erg

ANALYTICAL REPORT

ENVIRONMENTAL RESEARCH GROUP, INC.

ERG PROJECT NO. A1719 - JRB ASSOCIATES, INC 03-13-84

CLIENT I.D.: 85-0031 NZ05 - 115.5
ERG SAMPLE NO: 02/102583
MATRIX: SEDIMENT
DATE COLLECTED 02-06-84

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR — COMMENTS: INSUFFICIENT SAMPLE	*	
PHENOLS	ND (0.4)	mg/Kg
CHROMIUM, TOTAL	<2	mg/Kg
LEAD, TOTAL	<3	mg/Kg
SILVER, TOTAL	<0.8	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	ND (0.5)	mg/Kg
ORGANIC BROMIDE	ND (0.1)	mg/Kg
ORGANIC IODIDE	ND (0.05)	mg/Kg
CHLORDANE	ND (0.020)	mg/Kg
PERCENT MOISTURE	3	%
DDT, P,P'-	ND (0.020)	mg/Kg
DDE, P,P'-	ND (0.020)	mg/Kg
DDD, P,P'-	ND (0.020)	mg/Kg

CLIENT I.D.: 85-[illegible] NZ05 - 135.9
ERG SAMPLE NO: 02/[illegible]584
MATRIX: SEDIMENT
DATE COLLECTED 02-[illegible]-84

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	130	mg/Kg
PHENOLS	ND (0.2)	mg/Kg
CHROMIUM, TOTAL	20	mg/Kg
LEAD, TOTAL	4	mg/Kg
SILVER, TOTAL	ND (0.8)	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	ND (0.5)	mg/Kg
ORGANIC BROMIDE	ND (0.1)	mg/Kg
ORGANIC IODIDE	ND (0.05)	mg/Kg
CHLORDANE	ND (0.020)	mg/Kg
PERCENT MOISTURE	18	%
DDT, P,P'-	ND (0.020)	mg/Kg
DDE, P,P'-	ND (0.020)	mg/Kg
DDD, P,P'-	ND (0.020)	mg/Kg

 SEE LAST PAGE FOR EXPLANATION OF SYMBOLS CONTINUED

erg

ANALYTICAL REPORT

ENVIRONMENTAL RESEARCH GROUP, INC.

ERG PROJECT NO. A1719 - JRB ASSOCIATES, INC 03-13-84

FR - SEE FIELD REPORT FOR RESULT
NA - NOT APPLICABLE TO TEST REQUESTED
ND - NONDETECTED, DETECTION LIMIT IN ()
SD - SAMPLE DAMAGED
SR - SEE ATTACHED REPORT FOR RESULT
< - POSITIVE RESULT BUT AT UNQUANTIFIABLE
CONCENTRATION BELOW INDICATED LEVEL

THANK YOU FOR YOUR BUSINESS !

PAGE 8 LAST PAGE

QUALITY CONTROL SUMMARY

Submitted To:

JRB Associates, Inc.
8400 Westpark Drive
McLean, VA 22102

Attn: Claudia Wiegand

Project Number:	A2068 JRB-George
Date Sample Received:	June 21, 1984
Date Samples Extracted:	June 27, 1984
Date Samples Analyzed:	July 5, 1984, July 17, 1984, July 19, 1984, July 27, 1984, July 30, 1984
Methodology Employed:	Halocarbon Purgeables EPA Method 601 Pesticides EPA Method 608 EPA 600 Method for Chemical Analyis of Water and Wastes: Method 416.1
Sample Quality Control:	ERG's QA/QC requires a duplicate, method spike and blank with each group of samples or with every 10 samples, whichever is larger. The enclosed Quality Control Summary includes this data.

QUALITY CONTROL REPORT

JRB George: A2068

Sample Number	Parameter	Duplicate Value	Blank Value	Spike Level	Method Spike Value	% Recovery
110948	PCB	ND(0.20)/ND(0.20)	-----------	-----------	-----------------	----------
110940	p,p,'- DDT	ND(0.10)/ND(0.10)	ND(0.10)	0.4	0.396	99
110940	Chordane	ND(0.10)/ND(0.10)	ND(0.10)	1.25	1.11	89
110950	Silver	0.004/0.002	0.001	0.10	0.033	33
110950	Chromium	0.010/0.007	0.014	0.100	0.100	100
110950	Lead	0.017/0.018	0.004	0.20	0.188	94
110940	TOC	12.1/11.7	ND(2)	20	31.5	158
110953	TOC	4.0/4.4	ND(2)	20	26.7	134
110953	Bromide	ND(0.002)/ND(0.002)	0	2.5	2.6	104
110953	Chloride	1.14/1.11	0	25	23	92
110953	Iodide	0.002/0.004	0	2.5	2.3	92
*112201	Phenols	0.033/0.040	0.014	0.066	0.098	148

NOTE: Need Entire Sample for Oil & Grease. NO DUPLICATES

*This sample is not part of A2068 but was analyzed along with A2068.

erg™

ANALYTICAL REPORT

ENVIRONMENTAL RESEARCH GROUP, INC.
117 N. FIRST
ANN ARBOR, MICHIGAN 48104   (313) 662-3104

PROJECT   A2068
REPORT DATE   08-14-84

CLIENT P.O.: LETTER
REPORT: 8705

SAMPLES RECVD: 06-20-84
REFER TECHNICAL QUESTIONS
TO: JAMES HARLESS

CLIENT:
JRB ASSOCIATES, INC
8400 WESTPARK DRIVE
MC LEAN, VA 22102

APPROVED:

***
RESIDUAL SAMPLES WILL
BE HELD FOR TWO WEEKS
***

ATTENTION: CLAUDIA WIEGAND

CLIENT I.D.: NZ01 A
ERG SAMPLE NO: 06/110940
MATRIX: NATURAL WATER
DATE COLLECTED: 06-17-84

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	ND (0.5)	mg/L
PHENOLS	0.012	mg/L
CARBON, TOTAL ORGANIC,	12	mg/L
CHROMIUM, TOTAL	0.32	mg/L
LEAD, TOTAL	0.15	mg/L
SILVER, TOTAL	0.005	mg/L
HALOSCAN - T		
ORGANIC CHLORIDE	0.07	mg/L
ORGANIC BROMIDE	ND (0.002)	mg/L
ORGANIC IODINE	0.012	mg/L
DDT, p,p'-	ND (0.10)	ug/L
CHLORDANE	ND (0.10)	ug/L

CLIENT I.D.: NZ01 B
ERG SAMPLE NO: 06/110941
MATRIX: NATURAL WATER
DATE COLLECTED: 06-17-84

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	*	mg/L
COMMENTS: * FIRST SAMPLE ALIQUOT CONTAMINATED DURING ANALYSIS - UNABLE TO ANALYZE - SECOND ALIQUOT RECEIVED WAS BROKEN.		
PHENOLS	0.009	mg/L
CARBON, TOTAL ORGANIC,	8	mg/L
CHROMIUM, TOTAL	0.29	mg/L
LEAD, TOTAL	0.14	mg/L
SILVER, TOTAL	0.005	mg/L

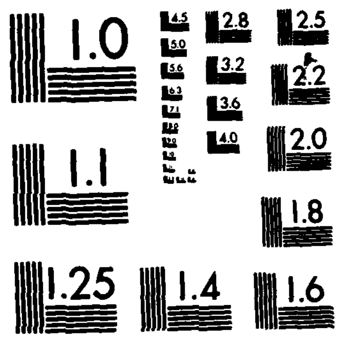
CONTINUED

 SEE LAST PAGE FOR EXPLANATION OF SYMBOLS

AD-A159 727 INSTALLATION RESTORATION PROGRAM PHASE II CONFIRMATION/QUANTIFICATION STA..(U) SCIENCE APPLICATIONS INTERNATIONAL CORP BELLEVE WA 3/3

UNCLASSIFIED R W GREILING ET AL. 30 AUG 85 SAIC-85/1790 F/G 13/2 NL

END



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

erg

ANALYTICAL REPORT

ENVIRONMENTAL RESEARCH GROUP, INC.

ERG PROJECT NO. A2068 - JRB ASSOCIATES, INC 08-14-84

CLIENT I.D.: NZ01 B
ERG SAMPLE NO: 06/110941
MATRIX: NATURAL WATER
DATE COLLECTED: 06-17-84

PARAMETER	RESULTS	UNITS
HALOSCAN - T		
ORGANIC CHLORIDE	0.06	mg/L
ORGANIC BROMIDE	0.003	mg/L
ORGANIC IODINE	0.020	mg/L
DDT, p,p'-	ND (0.10)	ug/L
CHLORDANE	ND (0.10)	ug/L

CLIENT I.D.: NZ02
ERG SAMPLE NO: 06/110942
MATRIX: NATURAL WATER
DATE COLLECTED: 06-17-84

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	0.6	mg/L
PHENOLS	0.030	mg/L
CARBON, TOTAL ORGANIC,	22	mg/L
CHROMIUM, TOTAL	0.01	mg/L
LEAD, TOTAL	0.03	mg/L
SILVER, TOTAL	ND (0.003)	mg/L
HALOSCAN - T		
ORGANIC CHLORIDE	0.29	mg/L
ORGANIC BROMIDE	0.008	mg/L
ORGANIC IODINE	0.006	mg/L
DDT, p,p'-	ND (0.10)	ug/L
CHLORDANE	ND (0.10)	ug/L

CLIENT I.D.: NZ03
ERG SAMPLE NO: 06/110943
MATRIX: NATURAL WATER
DATE COLLECTED: 06-17-84

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	<0.5	mg/L
PHENOLS	0.007	mg/L
CARBON, TOTAL ORGANIC,	27	mg/L
CHROMIUM, TOTAL	0.18	mg/L
LEAD, TOTAL	0.26	mg/L
SILVER, TOTAL	0.007	mg/L
HALOSCAN - T		
ORGANIC CHLORIDE	0.07	mg/L
ORGANIC BROMIDE	0.016	mg/L

CONTINUED

 SEE LAST PAGE FOR EXPLANATION OF SYMBOLS

CLIENT I.D.: NZ03
ERG SAMPLE NO: 06/110943
MATRIX: NATURAL WATER
DATE COLLECTED: 06-17-84

PARAMETER	RESULTS	UNITS
ORGANIC IODINE	0.005	mg/L
DDT, p,p'-	ND (0.10)	ug/L
CHLORDANE	ND (0.10)	ug/L

CLIENT I.D.: NZ04
ERG SAMPLE NO: 06/110944
MATRIX: NATURAL WATER
DATE COLLECTED: 06-17-84

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	<0.5	mg/L
PHENOLS	0.015	mg/L
CARBON, TOTAL ORGANIC,	3	mg/L
CHROMIUM, TOTAL	0.01	mg/L
LEAD, TOTAL	0.11	mg/L
SILVER, TOTAL	ND (0.003)	mg/L
HALOSCAN - T		
ORGANIC CHLORIDE	0.20	mg/L
ORGANIC BROMIDE	ND (0.002)	mg/L
ORGANIC IODINE	0.032	mg/L
DDT, p,p'-	ND (0.10)	ug/L
CHLORDANE	ND (0.10)	ug/L

CLIENT I.D.: NZ05
ERG SAMPLE NO: 06/110945
MATRIX: NATURAL WATER
DATE COLLECTED: 06-17-84

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	1	mg/L
PHENOLS	ND (0.004)	mg/L
CARBON, TOTAL ORGANIC,	5	mg/L
CHROMIUM, TOTAL	0.10	mg/L
LEAD, TOTAL	0.13	mg/L
SILVER, TOTAL	ND (0.003)	mg/L
HALOSCAN - T		
ORGANIC CHLORIDE	0.22	mg/L
ORGANIC BROMIDE	ND (0.002)	mg/L
ORGANIC IODINE	0.020	mg/L
DDT, p,p'-	ND (0.10)	ug/L
CHLORDANE	ND (0.10)	ug/L

CONTINUED

 SEE LAST PAGE FOR EXPLANATION OF SYMBOLS

erg™

ANALYTICAL REPORT

ENVIRONMENTAL RESEARCH GROUP, INC.

ERG PROJECT NO. A2068 - JRB ASSOCIATES, INC 08-14-84

CLIENT I.D.: MW 1
ERG SAMPLE NO: 06/110946
MATRIX: NATURAL WATER
DATE COLLECTED: 06-18-84

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	*	mg/L
COMMENTS: * FIRST SAMPLE ALIQUOT CONTAMINATED DURING ANALYSIS - UNABLE TO ANALYZE - SECOND ALIQUOT RECEIVED WAS BROKEN.		
PHENOLS	0.014	mg/L
CARBON, TOTAL ORGANIC,	3	mg/L
CHROMIUM, TOTAL	ND (0.01)	mg/L
LEAD, TOTAL	0.01	mg/L
SILVER, TOTAL	0.003	mg/L
HALOSCAN - T		
ORGANIC CHLORIDE	0.03	mg/L
ORGANIC BROMIDE	ND (0.002)	mg/L
ORGANIC IODINE	0.022	mg/L
DDT, p,p'-	ND (0.10)	ug/L
CHLORDANE	ND (0.10)	ug/L

CLIENT I.D.: CZ01 A
ERG SAMPLE NO: 06/110947
MATRIX: NATURAL WATER
DATE COLLECTED: 06-17-84

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	1.3	mg/L
CARBON, TOTAL ORGANIC,	6	mg/L
PCB		
TOTAL PCB	ND (0.20)	ug/L
PCB 1242	ND (0.20)	ug/L
PCB 1248	ND (0.20)	ug/L
PCB 1254	ND (0.20)	ug/L
PCB 1260	ND (0.20)	ug/L

CLIENT I.D.: CZ01 B
ERG SAMPLE NO: 06/110948
MATRIX: NATURAL WATER
DATE COLLECTED: 06-17-84

PARAMETER	RESULTS	UNITS
PCB		
TOTAL PCB	ND (0.20)	ug/L
PCB 1242	ND (0.20)	ug/L
PCB 1248	ND (0.20)	ug/L
PCB 1254	ND (0.20)	ug/L

CONTINUED

 SEE LAST PAGE FOR EXPLANATION OF SYMBOLS

ANALYTICAL REPORT

ENVIRONMENTAL RESEARCH GROUP, INC.

ERG PROJECT NO. A2068 - JRB ASSOCIATES, INC 08-14-84

CLIENT I.D.: CZ01 B
ERG SAMPLE NO: 06/110948
MATRIX: NATURAL WATER
DATE COLLECTED: 06-17-84

PARAMETER	RESULTS	UNITS
PCB 1260	ND (0.20)	ug/L

CLIENT I.D.: SZ01
ERG SAMPLE NO: 06/110949
MATRIX: NATURAL WATER
DATE COLLECTED: 06-17-84

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	14	mg/L
PHENOLS	0.020	mg/L
CARBON, TOTAL ORGANIC,	3	mg/L
CHROMIUM, TOTAL	0.02	mg/L
LEAD, TOTAL	0.04	mg/L
SILVER, TOTAL	0.004	mg/L
HALOSCAN - T		
ORGANIC CHLORIDE	0.95	mg/L
ORGANIC BROMIDE	ND (0.002)	mg/L
ORGANIC IODINE	0.062	mg/L
DDT, p,p'-	ND (0.10)	ug/L
CHLORDANE	ND (0.10)	ug/L

CLIENT I.D.: SZ02 A
ERG SAMPLE NO: 06/110950
MATRIX: NATURAL WATER
DATE COLLECTED: 06-18-84

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	0.8	mg/L
PHENOLS	0.016	mg/L
CARBON, TOTAL ORGANIC,	2	mg/L
CHROMIUM, TOTAL	<0.01	mg/L
LEAD, TOTAL	0.02	mg/L
SILVER, TOTAL	0.003	mg/L
HALOSCAN - T		
ORGANIC CHLORIDE	0.51	mg/L
ORGANIC BROMIDE	ND (0.002)	mg/L
ORGANIC IODINE	0.009	mg/L
DDT, p,p'-	ND (0.10)	ug/L
CHLORDANE	ND (0.10)	ug/L

CONTINUED

 SEE LAST PAGE FOR EXPLANATION OF SYMBOLS

erg

ANALYTICAL REPORT

ENVIRONMENTAL RESEARCH GROUP, INC.

ERG PROJECT NO. A2068 - JRB ASSOCIATES, INC 08-14-84

CLIENT I.D.: SZ02 B
ERG SAMPLE NO: 06/110951
MATRIX: NATURAL WATER
DATE COLLECTED: 06-18-84

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	ND (0.5)	mg/L
PHENOLS	<0.004	mg/L
CARBON, TOTAL ORGANIC,	ND (2)	mg/L
CHROMIUM, TOTAL	0.09	mg/L
LEAD, TOTAL	0.06	mg/L
SILVER, TOTAL	<0.003	mg/L
HALOSCAN - T		
ORGANIC CHLORIDE	0.71	mg/L
ORGANIC BROMIDE	ND (0.002)	mg/L
ORGANIC IODINE	0.008	mg/L
DDT, p,p'-	ND (0.10)	ug/L
CHLORDANE	ND (0.10)	ug/L

CLIENT I.D.: SZ03
ERG SAMPLE NO: 06/110952
MATRIX: NATURAL WATER
DATE COLLECTED: 06-18-84

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	0.7	mg/L
PHENOLS	ND (0.004)	mg/L
CARBON, TOTAL ORGANIC,	5	mg/L
CHROMIUM, TOTAL	0.04	mg/L
LEAD, TOTAL	0.06	mg/L
SILVER, TOTAL	0.003	mg/L
HALOSCAN - T		
ORGANIC CHLORIDE	0.80	mg/L
ORGANIC BROMIDE	ND (0.002)	mg/L
ORGANIC IODINE	0.015	mg/L
DDT, p,p'-	ND (0.10)	ug/L
CHLORDANE	ND (0.10)	ug/L

CLIENT I.D.: SZ04
ERG SAMPLE NO: 06/110953
MATRIX: NATURAL WATER
DATE COLLECTED: 06-18-84

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	<0.5	mg/L
PHENOLS	ND (0.004)	mg/L
CARBON, TOTAL ORGANIC,	4	mg/L

CONTINUED

ANALYTICAL REPORT

ENVIRONMENTAL RESEARCH GROUP, INC.

ERG PROJECT NO. A2068 - JRB ASSOCIATES, INC 08-14-84

CLIENT I.D.: SZ04
ERG SAMPLE NO: 06/110953
MATRIX: NATURAL WATER
DATE COLLECTED: 06-18-84

PARAMETER	RESULTS	UNITS
CHROMIUM, TOTAL	0.10	mg/L
LEAD, TOTAL	0.07	mg/L
SILVER, TOTAL	0.005	mg/L
HALOSCAN - T		
ORGANIC CHLORIDE	1.1	mg/L
ORGANIC BROMIDE	ND (0.002)	mg/L
ORGANIC IODINE	0.003	mg/L
DDT, p,p'-	ND (0.10)	ug/L
CHLORDANE	ND (0.10)	ug/L

TOC SAMPLES #06/110940 THROUGH 06/110953 HAD FINE SILT SEDIMENT LAYER RANGING FROM LIGHT TO HEAVY BEFORE BEING SHOOK-UP.

FR - SEE FIELD REPORT FOR RESULT
NA - NOT APPLICABLE TO TEST REQUESTED
ND - NONDETECTED, DETECTION LIMIT IN ()
SD - SAMPLE DAMAGED
SR - SEE ATTACHED REPORT FOR RESULT
< - POSITIVE RESULT BUT AT UNQUANTIFIABLE CONCENTRATION BELOW INDICATED LEVEL

THANK YOU FOR YOUR BUSINESS !

PAGE 7 LAST PAGE

APPENDIX G

EXFILTRATION DATA TABLES AND PLOTS

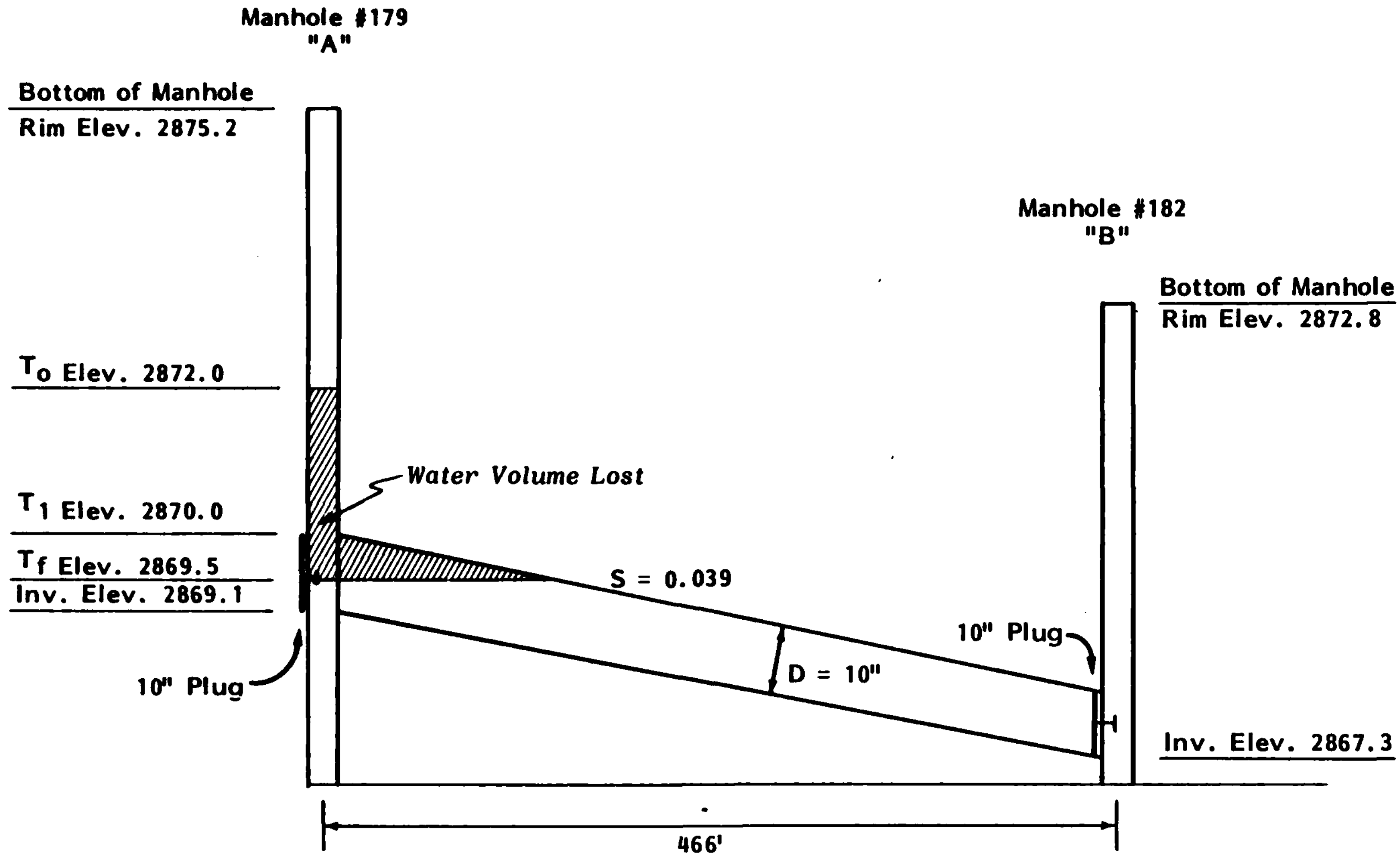


Figure G-1

LINE SEGMENT "AB" PROFILE, WATER SURFACE MEASUREMENTS AND GRAPHIC PORTRAYAL OF WATER LOST DURING EXFILTRATION TEST PERIOD

Table G-1

RAW AND SUMMARIZED FIELD DATA FOR MANHOLE A (LINE SEGMENT AB)

Time	ΔT (min)	ΣT (min)	Water[a] Surface in Manhole (inches)	Δ Water Surface (inches)	Σ Water Surface (inches)	Rate (in/min)
0820			38.25			
	5	5		9.75	9.75	1.95
0825			48.0			
	5	10		12.50	22.25	2.50
0830			60.5			
	5	15		1.5	23.75	0.3
0835			62.0			
	5	20		1.5	25.25	0.3
0840			63.5			
	5	25		0.5	25.75	0.1
0845			63.75			
	15	40		1.5	27.25	0.1
0900			65.25			
	16	56		0.75	28.0	0.05
0916			66.0			
	15	71		0.5	28.5	0.03
0931			66.5			
	11	82		0.5	29.0	0.045
0942			67.0			
	14	96		0.5	29.5	0.036
0956			67.5			
	22	118		0.5	30.0	0.020
1018			68.0			
	16	134		0.0	30.0	0.0
1034			68.0			
	81	215		0.5	30.5	0.006
1155			68.5			

[a]Water surface as measured from rim of manhole.

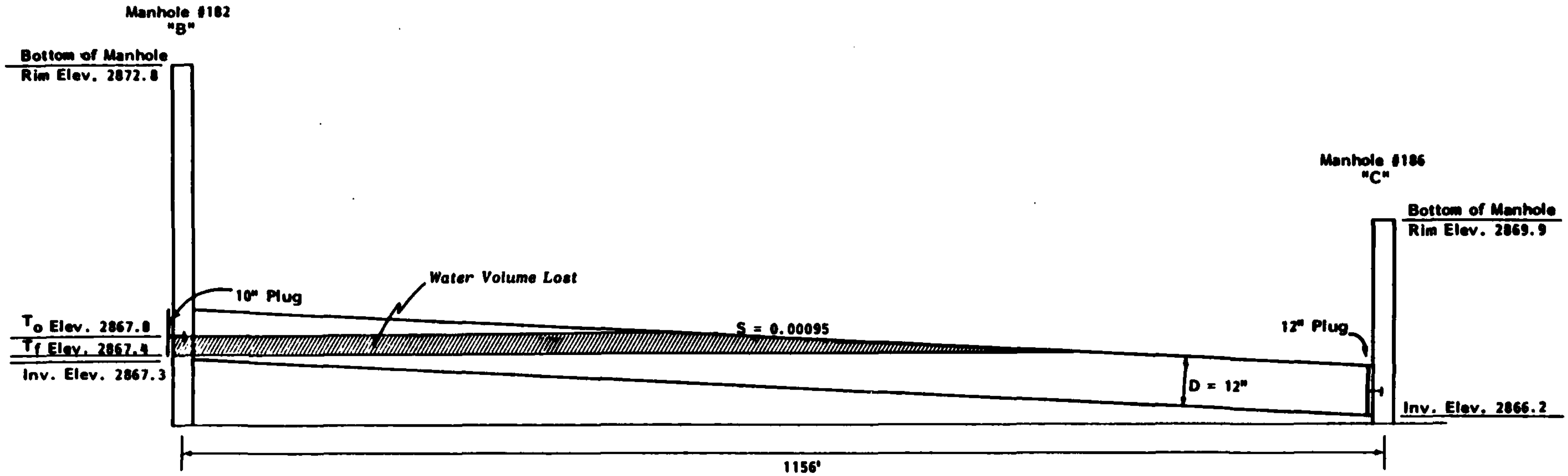


Figure G-2

LINE SEGMENT "BC" PROFILE, WATER SURFACE MEASUREMENTS AND GRAPHIC PORTRAYAL OF WATER LOST DURING EXFILTRATION TEST PERIOD

Table G-2

RAW AND SUMMARIZED FIELD DATA FOR MANHOLE B (LINE SEGMENT BC)

Time	ΔT (min)	ΣT (min)	Water[a] Surface in Manhole (inches)	Δ Water Surface (inches)	Σ Water Surface (inches)	Rate (in/min)
0905			60.5			
	2	2		3.0	3.0	1.5
0907			63.5			
	1	3		0.5	3.5	0.5
0908			64.0			
	2	5		0.5	4.0	0.25
0910			64.5			
	4	9		0.0	4.0	0.0
0914			64.5			
	6	15		0.0	4.0	0.0
0920			64.5			
	5	20		0.0	4.0	0.0
0925			64.5			
	6	26		0.0	4.0	0.0
0931			64.5			
	14	40		0.0	4.0	0.0
0945			64.5			
	10	50		0.0	4.0	0.0
0955			64.5			
	22	72		0.0	4.0	0.0
1017			64.5			
	15	87		0.0	4.0	0.0
1032			64.5			
	83	170		0.0	4.0	0.0
1155			64.5			

[a]Water surface as measured from rim of manhole.

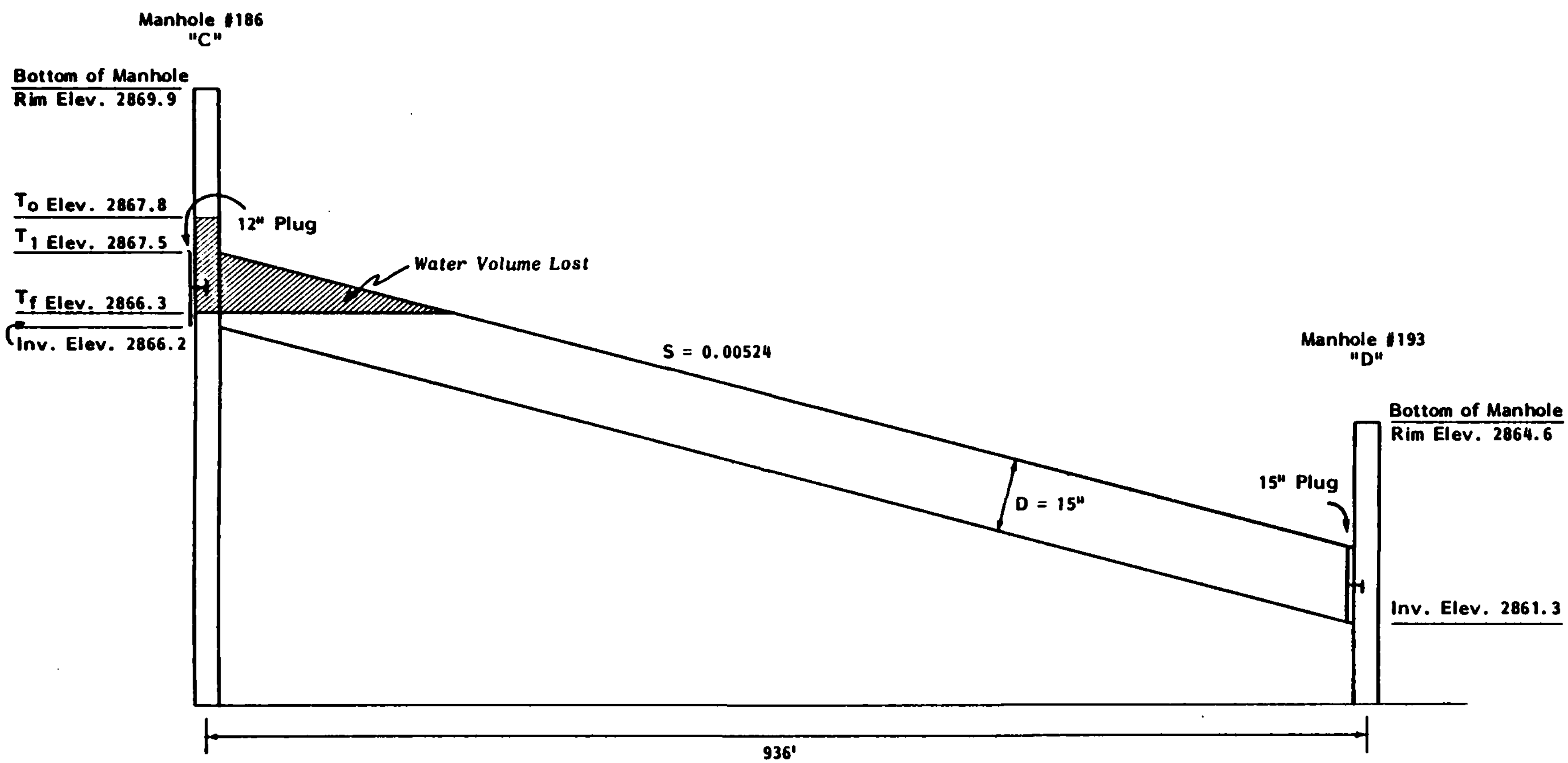


Figure G-3

LINE SEGMENT "CD" PROFILE, WATER SURFACE MEASUREMENTS AND GRAPHIC PORTRAYAL OF WATER LOST DURING EXFILTRATION TEST PERIOD

Table G-3

RAW AND SUMMARIZED FIELD DATA FOR MANHOLE C (LINE CD)

Time	ΔT (min)	ΣT (min)	Water[a] Surface in Manhole (inches)	Δ Water Surface (inches)	Σ Water Surface (inches)	Rate (in/min)
0925			25.0			
	6	6		7.0	7.0	1.17
0931			32.0			
	5	11		4.25	11.25	0.85
0936			36.25			
	4	15		2.0	13.25	0.50
0940			38.25			
	6	21		0.75	14.0	0.13
0946			39.0			
	7	28		1.75	15.75	0.25
0953			40.75			
	22	50		2.25	18.0	0.10
1015			43.0			
	13	63		0.5	18.5	0.04
1028			43.5			
	87	150		0.75	19.25	0.008
1155			44.25			

[a]Water surface as measured from rim of manhole.

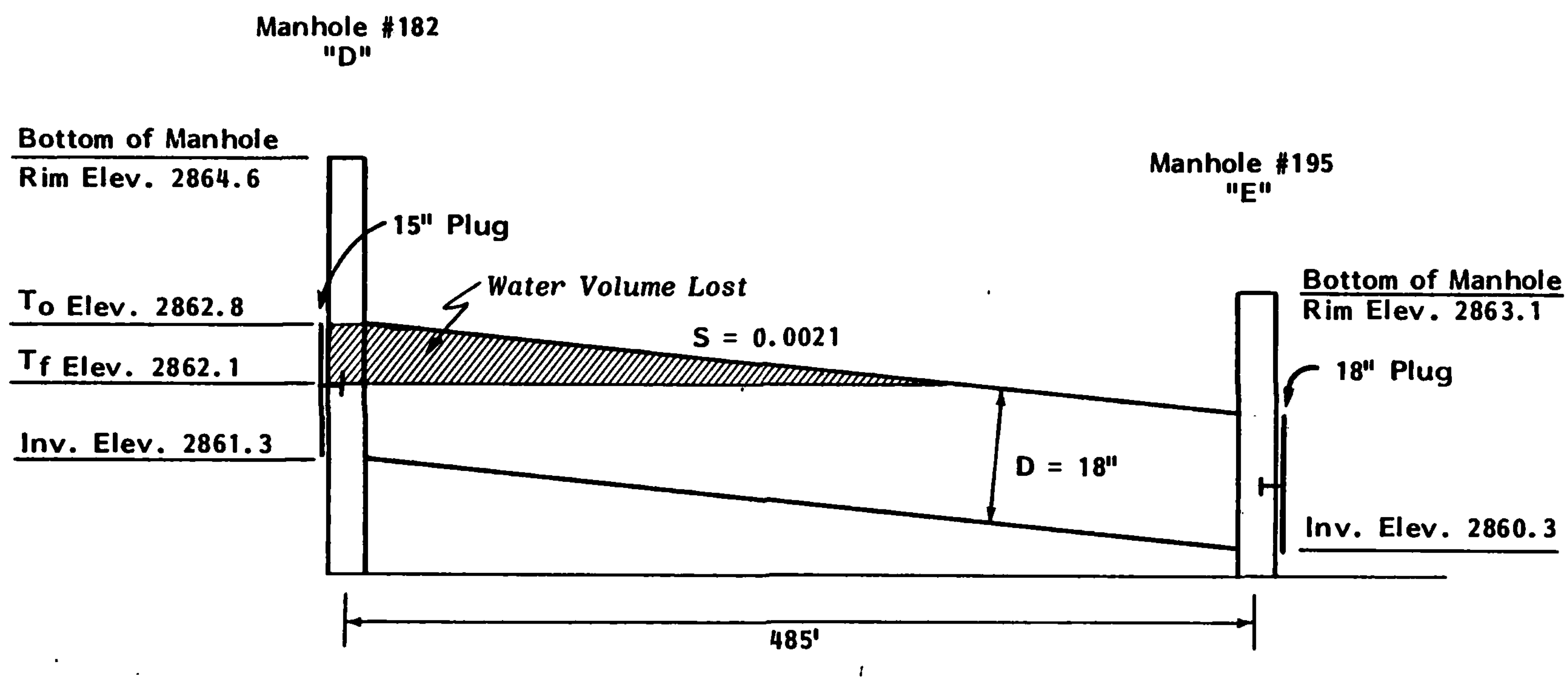


Figure G-4

LINE SEGMENT "DE" PROFILE, WATER SURFACE MEASUREMENTS AND GRAPHIC PORTRAYAL OF WATER LOST DURING EXFILTRATION TEST PERIOD

Table G-4

RAW AND SUMMARIZED FIELD DATA FOR MANHOLE D (LINE SEGMENT DE)

Time	ΔT (min)	ΣT (min)	Water[a] Surface in Manhole (inches)	Δ Water Surface (inches)	Σ Water Surface (inches)	Rate (in/min)
1010			22.25			
	14	14		2.0	2.0	0.14
1024			24.25			
	6	20		0.5	2.5	0.08
1030			24.75			
	85	105		2.75	5.25	0.03
1155			27.5			
	20	125		1.0	6.25	0.05
1215			28.5			
	270	395		1.5	7.75	0.006
1645			30.0			

[a]Water surface as measured from rim of manhole.

Table G-5

DETERMINATION OF WATER EXFILTRATION RATES IN SELECTED LINE SEGMENTS OF THE INDUSTRIAL/STORM DRAIN LINE AT GEORGE AIR FORCE BASE

Line Segment	Table/ Figure Reference	Sum of Water Volume Loss (ft^3/gal)	Effective Time Interval (min)	Effective Exfiltration Rate (gpd)	(gpd/in.diam/ft)*
AB	G-1	31.93/238.8	134	2,570	0.6
BC	G-2	194.85/1457.5	5	419,800	30.3
CD	G-3	148.24/1108.8	150	10,645	0.7
DE	G-4	162.47/1215.3	395	4,430	0.5

*Contemporary sewer construction specifications call for an allowable infiltration/exfiltration rate of 0.05 to 0.10 gallons per day per inch diameter per foot of pipe (or approximately 250 to 500 gpd/in.diam./mile).

Source: Design and Construction of Sanitary and Storm Sewers, WPCF Manual of Practice No. 9 (ASCE Manuals and Reports on Engineering Practice No. 37), Water Pollution Control Federation, Washington, D.C. (1970).

APPENDIX H

CALIFORNIA LAMBERT COORDINATE SYSTEM

(Source: Moffit & Bouchard, 1975)

CALIFORNIA COORDINATE SYSTEM

§ 8801. California coordinate system. The system of plane coordinates which has been established by the United States Coast and Geodetic Survey for defining and stating the positions or locations of points on the surface of the earth within the State of California is the "California Coordinate System." (Added Stats. 1953, c. 108, p 832, § 1.)

§ 8802. Division of state into zones; area included in each of the zones designated. For the purpose of the use of the California Coordinate System the State is divided into seven zones.

The area in the following counties constitutes Zone 1: Del Norte, Humboldt, Lassen, Modoc, Plumas, Shasta, Siskiyou, Tehama, and Trinity.

The area included in the following counties constitutes Zone 2: Alpine, Amador, Butte, Colusa, El Dorado, Glenn, Lake, Mendocino, Napa, Nevada, Placer, Sacramento, Sierra, Solano, Sonoma, Sutter, Yolo, and Yuba.

The areas included in the following counties constitutes Zone 3: Alameda, Calaveras, Contra Costa, Madera, Marin, Mariposa, Merced, Mono, San Francisco, San Joaquin, San Mateo, Santa Clara, Santa Cruz, Stanislaus, and Tuolumne.

The area included in the following counties constitutes Zone 4: Fresno, Inyo, Kings, Monterey, San Benito, and Tulare.

The area included in the following counties constitutes Zone 5: Kern, San Bernardino, San Luis Obispo, Santa Barbara, and Ventura.

The area included in the following counties constitutes Zone 6: Imperial, Orange, Riverside, and San Diego.

The area included in Los Angeles County constitutes Zone 7. (Added Stats. 1953. c. 108, p. 833, § 1.)

§ 8803. California coordinate system, zone 1. As established for use in Zone 1, the California Coordinate System shall be named, and on any map on which it is used it shall be designated, the "California Coordinate System, Zone 1."

The California Coordinate System, Zone 1, is a Lambert conformal projection of the Clarke spheroid of 1866, having standard parallels at north latitudes 40 degrees 00 minutes and 41 degrees 40 minutes, along which parallels the scale shall be exact. The point of control of coordinates is at the intersection of the meridian 122 degrees 00 minutes west longitude with the

parallel 39 degrees 20 minutes north latitude, such point of control being given the coordinates: x (east) = 2,000,000 feet and y (north) = 0 feet. (Added Stats. 1953, c. 108, p. 833, § 1.)

§ 8804. California coordinate system, zone 2. As established for use in Zone 2, the California Coordinate System shall be named, and on any map on which it is used it shall be designated, the "California Coordinate System, Zone 2."

The California Coordinate System, Zone 2, is a Lambert conformal projection of the Clarke spheroid of 1866, having standard parallels at north latitudes 38 degrees 20 minutes and 39 degrees 50 minutes, along which parallels the scale shall be exact. The point of control of coordinates is at the intersection of the meridian 122 degrees 00 minutes west longitude with the parallel 37 degrees 40 minutes north latitude, such point of control being given the coordinates: x (east) = 2,000,000 feet and y (north) = 0 feet. (Added Stats. 1953, c. 108, p. 833, § 1.)

§ 8805. California coordinate system, zone 3. As established for use in Zone 3, the California Coordinate System shall be named, and on any map on which it is used shall be designated, the "California Coordinate System, Zone 3."

The California Coordinate System, Zone 3, is a Lambert conformal projection of the Clarke spheroid of 1866, having standard parallels at north latitudes 37 degrees 04 minutes and 38 degrees 26 minutes, along which parallels the scale shall be exact. The point of control of coordinates is at the intersection of the meridian 120 degrees 30 minutes west longitude with the parallel 36 degrees 30 minutes north latitude, such point of control being given the coordinates: x (east) = 2,000,000 feet and y (north) = 0 feet. (Added Stats. 1953, c. 108, p. 833, § 1.)

§ 8806. California coordinate system, zone 4. As established for use in Zone 4, the California Coordinate System shall be named, and on any map on which it is used it shall be designated, the "Calfornia Coordinate System, Zone 4."

The California Coordinate System, Zone 4, is a Lambert conformal projection of the Clarke spheroid of 1866, having standard parallels at north latitudes 36 degrees 00 minutes and 37 degrees 15 minutes, along which parallels the scale shall be exact. The point of control of coordinates is at the intersection of the meridian 119 degrees 00 minutes west longitude with the parallel 35 degrees 20 minutes north latitude, such point of control being given the coordinates: x (east) = 2,000,000 feet and y (north) = 0 feet. (Added Stats. 1953, c. 108, p. 834, § 1.)

§ 8807. California coordinate system, zone 5. As established for use in Zone 5, the California Coordinate System shall be named and on any map on which it is used shall be designated, the "California Coordinate System, Zone 5."

The California Coordinate System, Zone 5, is a Lambert conformal projection of the Clarke spheroid of 1866, having standard parallels at north latitudes 34 degrees 02 minutes and 35 degrees 28 minutes, along which parallels the scale shall be exact. The point of control of coordinates is at the intersection of the meridian 118 degrees 00 minutes west longitude with the parallel

33 degrees 30 minutes north latitude, such point of control being given the coordinates: x (east) = 2,000,000 feet and y (north) = 0 feet. (Added Stats. 1953, c. 108, p. 834, § 1.)

§ 8808. **California coordinate system, zone 6.** As established for use in Zone 6, the California Coordinate System shall be named, and on any map on which it is used it shall be designated, the "California Coordinate System, Zone 6."

The California Coordinate System, Zone 6, is a Lambert conformal projection of the Clarke spheroid of 1866, having standard parallels at north latitudes 32 degrees 47 minutes and 33 degrees 53 minutes, along which parallels the scale shall be exact. The point of control of coordinates is at the intersection of the meridian 116 degrees 15 minutes west longitude with the parallel 32 degrees 10 minutes north latitude, such point of control being given the coordinates: x (east) = 2,000,000 feet and y (north) = 0 feet. (Added Stats. 1953, c. 108, p. 834, § 1.)

§ 8809. **California coordinate system, zone 7.** As established for use in Zone 7, the California Coordinate System shall be named, and on any map on which it is used it shall be designated, the "California Coordinate System, Zone 7."

The California Coordinate System, Zone 7, is a Lambert conformal projection of the Clarke spheroid of 1866, having standard parallels at north latitudes 33 degrees 52 minutes and 34 degrees 25 minutes, along which parallels the scale shall be exact. The point of control of coordinates is at the intersection of the meridian 118 degrees 20 minutes west longitude with the parallel 34 degrees 08 minutes north latitude, such point of control being given the coordinates: x (east) = 4,186,692.58 feet and y (north) = 4,160,926.74 feet. (Added Stats. 1953, c. 108, p. 834, § 1.)

§ 8810. **What plane coordinates consist of.** The plane coordinates of a point on the earth's surface, to be used in expressing the position or location of the point in the appropriate zone of this system, shall consist of two distances, expressed in feet and decimals of a foot. One of these distances, to be known as the "x-coordinate," shall give the position in an east-and-west direction from the Y axis; the other, to be known as the "y-coordinate," shall give the position in a north-and-south direction from the X axis. The Y axis of any zone shall be parallel with the meridian passing through the point of control of that zone. The X axis of any zone shall be at right angles to the meridian which passes through the point of control of that zone. (Added Stats. 1953, c. 108, p. 835, § 1.)

§ 8811. **Depending upon and conformity with plane coordinates of triangulation and traverse stations of United States Coast and Geodetic Survey within state.** The plane coordinates of a point in any zone shall be made to depend upon and conform with the plane coordinates of the triangulation and traverse stations of the United States Coast and Geodetic Survey within the State of California, as those coordinates shall be determined to conform with the provisions of this chapter. (Added Stats. 1953, c. 108, p. 835, § 1.)

§ 8812. **Survey extending from one zone into another; positions delineated; naming zone used.** If the survey of any parcel of land extends from one coordinate zone into another, the positions of all points delineated upon the

map thereof may be referred to either of these zones. The zone which is used shall be specifically named in the title upon the map. (Added Stats. 1953, c. 108, p. 835, § 1.)

§ 8813. Manner of marking position of California coordinate system; requirements of survey or map. The position of the California Coordinate System shall be as marked on the ground by triangulation or traverse stations whose geodetic positions have been rigidly adjusted on the North American datum of 1927 and established in conformity with the standards adopted by the United States Coast and Geodetic Survey for first-order and second-order work, and whose coordinates have been computed on the system defined. Any survey or map purported to be based on the California Coordinate System shall have established connections to at least two of such stations. (Added Stats. 1953, c. 108, p. 835, § 1, as amended Stats. 1953, c. 853, p. 2182, § 2.)

HISTORICAL NOTE

The 1953 amendment relocated in the first sentence the phrase "whose geodetic positions have been rigidly adjusted on the North American datum of 1927." Previously the phrase followed the reference to standards for first-order and second-order work.

The 1953 amendatory act, in section 1 thereof, made a similar amendment to Stats. 1947, c. 1307, p. 2845, § 5.

Section 3 of the 1953 amendatory act read: "Section 2 of this act becomes operative only if Division 8 of the Public Resources Code is enacted by the Legislature at its 1953 Regular Session, and in such case at the same time as said Division 8 takes effect, at which time Section 5 of Chapter 1307 of the Statutes of 1947, as amended by this act, is repealed."

§ 8814. Requirements of map, survey, conveyance or other instrument to constitute, when recorded, constructive notice, reference to recorded data controlling in case of conflict. Any map, survey, conveyance or other instrument delineating, or affecting the title to, real property which delineates, describes or refers to such property, or any part thereof, by reference to coordinates based on the California Coordinate System shall, in order to constitute, when recorded, constructive notice thereof under the recording laws, also delineate, describe or refer to such property, or such part thereof, by reference to data appearing of record in any office the records of which constitute constructive notice under the recording laws, sufficient to identify it without recourse to such coordinates; and in case of conflict between them the references to such recorded data shall be controlling. (Added Stats. 1953, c. 1195, p. 2710, § 2.)

HISTORICAL NOTE

Former section 8814, added by Stats. 1953, c. 108, p. 835, § 1, repealed by Stats. 1953, c. 1195, p. 2710, § 1, read: "If any instrument affecting the title to real property contains a reference to a point or line established in accordance with the California Coordinate System of Surveying and also a reference to a point or line established with reference to data appearing of record in the county recorder's office, in a manner which will cause a conflict in position, the reference to the point or line established with reference to recorded data is controlling."

§ 8815. Use of term limited to coordinates based on California coordinate system The use of the term "California Coordinate System" on any map or in any field notes referring to the system shall be limited to coordinates based on the California Coordinate System as defined in this chapter. (Added Stats. 1953, c. 108, p. 836, § 1.)

§ 8816. Use of system optional. The use of the California Coordinate System by any person, corporation, or governmental agency engaged in land surveying or mapping is optional. (Added Stats. 1953, c. 108, p. 836, § 1.)

APPENDIX I

QA/QC/CHAIN OF CUSTODY

1.0 FIELD SAMPLE CUSTODY

Chain of custody procedures were employed with all collected groundwater samples in the project. An example of the chain of custody form currently being used by SAIC is shown in Figure I-1. The procedures are straight forward and follow common sense rules. A brief summary of the salient features is presented below.

When the sample was initially taken, it was logged, identified, and labeled. This included at least the site, depth of sample, sample type, date, time, and sampling person. The field sampling person has primary responsibility for proper maintenance of the sample in the field. When the samples were shipped to the laboratory, SAIC prepared and packed all samples in ice, sealed the coolers, and transferred the samples to the airline freight forwarding company. Signatures of the freight personnel at each shipping or transfer point were required. When the sample arrived at the lab, designated personnel received the samples, asked the delivery person for a sign off on the condition of the shipment, and then began the preparation process for each sample until analysis. Upon receipt at the lab all samples were logged into the laboratory chain of custody and tracking system.

Once the samples have been analyzed, any remaining unanalyzed sample aliquots are kept in the laboratory tracking system until the end of the project. Final extracts or solutions used in the analytical process are also logged into the tracking system and stored in controlled access freezers and coolers throughout the life of the project. At the end of the project, SAIC will seek instructions from the USAF on the final disposition of the samples. If after 120 days from the end date of the project instructions have not been received, SAIC will dispose of the samples in an appropriate manner.

2.0 LABORATORY SAMPLE CUSTODY

Sample custody is maintained at SAIC's analytical laboratory through the use of several tracking systems designed to protect sample integrity. Mechanisms utilized to ensure sample integrity include formal chain of custody documentation, locked sample storage, analysis request forms, and routine sample status review by laboratory and program managers.

For programs not requiring field collection by SAIC personnel, the sample tracking system will be initiated immediately upon receipt at SAIC's analytical facility. An overview of the sample tracking and chain of custody procedure to be used is presented in the flow diagram illustrated in Figure I-2. This procedure includes the following components:

1. Upon arrival all samples are inspected to insure that each sample is intact. This inspection will include examination of sample seals (when stringent chain of custody is required) and anomalies are noted in the SAIC sample log book, chain of custody form and the client is alerted.

SAIC Science Applications International Corporation	SAMPLE CHAIN OF CUSTODY LOG	Shipment No. ______
Project:	Reason for Transfer:	

	Sampling Date	Start Time	Sample Location	Sample ID	R-Rep B-Blk S-Sam	Matrix / Media	# Items or Containers	Comments
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
Column Total:								

Signature & Affiliation PLEASE

Relinquished by/Affiliation:	Received by/Affiliation:	Date/Time:	Condition:
Relinquished by/Affiliation:	Received by/Affiliation:	Date/Time:	Condition:
Relinquished by/Affiliation:	Received by/Affiliation:	Date/Time:	Condition:
Relinquished by/Affiliation:	Received by/Affiliation:	Date/Time:	Condition:

SAIC/ETG 13400-B Northup Way, Suite 38, Bellevue, Washington 98005 (206) 747-7899

Page ______ of ______

White - Return to Original Sampler (above address)
Yellow - Laboratory Record
Pink - Retained by Original Sampler

Figure I-1

EXAMPLE IRP CHAIN OF CUSTODY LOG

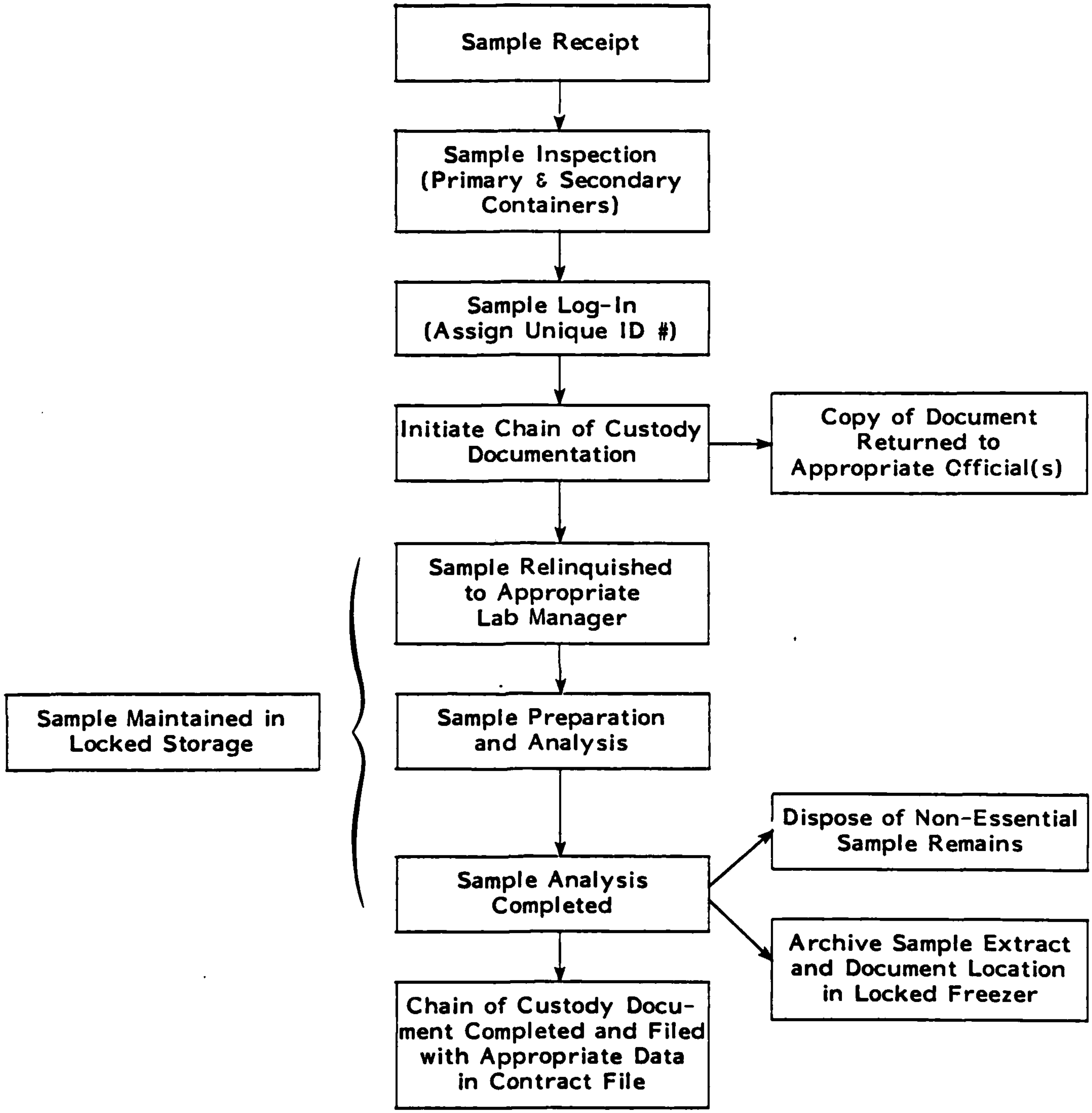


Figure I-2

CHAIN OF CUSTODY/SAMPLE TRACKING FLOW DIAGRAM

2. Each sample is assigned a unique SAIC sample identification number (cross-coded with the project's field numbering). Sample identification information is kept in a bound log book and this ID number is used to track sample location and status throughout the analytical facility.

3. When formal chain of custody is required, the chain of custody document is initiated when the sample is relinquished by the courier to the laboratory for analysis.

4. The field chain of custody document is completed and carbon copies are returned to the appropriate party(s).

5. The following information is recorded in the SAIC sample log book: sample origin, customer and project information, time and date of receipt, sample type, analysis required, preservatives, and pertinent comments.

6. After the sample is logged in and chain of custody is initiated, an internal chain of custody/tracking document is generated.

7. This internal chain of custody document (Figure I-3) requires that the sample be formally relinquished by one party and accepted by the other at each step of the analytical process. This document accompanies the sample through each step of the analytical process.

8. While within SAIC's laboratory, sample integrity is maintained through the use of locked storage areas. Samples remain in locked storage areas except when actively involved in the analytical process.

9. When analytical activities are completed, internal and external chain of custody documents are completed and filed in the appropriate contract file.

10. According to contract requirements, sample remains are either archived in locked storage areas or disposed of properly.

11. A formal record is kept on archived samples until ultimate disposition is determined.

In addition to the external and internal chain of custody documents, analysis request forms (see Figure I-4) are utilized to further control sample flow and facilitate tracking within the analytical facility. Within each functional lab unit, the laboratory manager is responsible for maintaining sample integrity, fulfilling chain of custody requirements, scheduling sample flow, and tracking sample status. These activities are facilitated through the use of the above referenced documents and formal laboratory notebooks.

All laboratory personnel are required to maintain permanent laboratory notebooks which document all activities associated with the analytical process. Laboratory notebooks are the fundamental record of each staff member and are bound pre-numbered volumes. The WA officer assigns these notebooks, stores

PROJECT NAME: ______________________ PROJECT NUMBER: ____________ PAGE ___ OF ___

COLLECTION LOCATION:				SAMPLERS:		
SAMPLE NUMBER	DATE	TIME	SAMPLE TYPE	# OF CONTAINERS	PRESERVATIVES ADDED	REMARKS

RELINQUISHED BY:	DATE/TIME: ____________ REASON:	RECEIVED BY:
RELINQUISHED BY:	DATE/TIME: ____________ REASON:	RECEIVED BY:
RELINQUISHED BY:	DATE/TIME: ____________ REASON:	RECEIVED BY:
RELINQUISHED BY:	DATE/TIME: ____________ REASON:	RECEIVED BY:

Figure I-3

INTERNAL CHAIN OF CUSTODY FORM

ANALYSIS REQUEST FORM

Date Submitted______________ Person Submitting Samples______________

Contract______________ Labor & Analysis Charge No.______________

Sample No.	Sample Type	Analysis Required

Standards submitted______________

Do you want these analyses on cassette tape?______________

Spectra or Chromatograms to:______________

Sample remainders to:______________

Data analyses required______________

Comments or Suggestions:______________

Figure I-4

INTERNAL ANALYSIS REQUEST FORM

full ones, logs location of notebooks and dates of use, and reviews them regularly. Several rules govern the use of the these notebooks:

1. Only assigned lab notebooks are used for record-keeping related to project work.

2. All writing must be legible and in ink, and all numbers must be clear. Errors are crossed out with single lines rather than by erasing or over-writing. All entries must be dated.

3. The first one or two pages are left blank for a Table of Contents to be filled in as project tasks are completed.

4. Project goals are included as are plans for achieving them, including specific references, considering that another person might have to write a report with only the information in a notebook. Efforts are made to be as specific as possible, avoiding the assumption that another person who reads a description will understand information that is not available.

5. All relevant information is included (e.g., the manufacturer and lot number of a chemical, the specific procedure used for each sample preparation and analysis, instrumental conditions, etc.).

6. All tables and graphs are labeled clearly and any abbreviations explained. Terms used in equations are defined. No loose papers are included.

7. If any data are determined to be invalid, reasons are indicated.

8. Draw appropriate conclusions following the completion of laboratory experiments, stating reasons for the conclusions.

9. When work is continued in another notebook, the number of the second notebook is written in the first notebook and vice versa.

When each analysis is complete, the analyst will review data relative to correlative QA/QC results and/or make comparisons with other analysts' results on similar samples. The analyst is usually the first to notice unusual results at the individual parameter level (spiked, duplicates, standards, etc.). If any problem is detected, the analyst will consult with the Project Manager and the Division's QA officer regarding needs for retesting or to discuss the use of an alternative procedure.

A second check at the individual parameter level is performed by the investigator responsible for interpreting and/or reporting the results. The chemist checks QA/QC results (control chart adherence, reference samples, blanks, spikes and duplicates) from the raw data and sample results through calculations to the final reported value. If results are unsatisfactory, the analyst is informed and retesting is scheduled (either by the original analyst or a third party analyst) or other means of rectifying the situation are implemented.

Finally, the Division's QA officer reviews the analytical results as a whole from the raw data with emphasis on blanks, precision and accuracy data, significant figures, and the overall "sense" of the results and their interrelationships. Any problems are referred to the analyst and Program Manager for resolution to the satisfaction of the QA officer.

APPENDIX J

SAFETY PLAN

1.0 SAFETY PLAN

1.1 PURPOSE

The purpose of this safety plan is to summarize the procedures used by Science Applications International Corporation (SAIC) to accomplish the USAF Installation Restoration Program Phase II field survey at George AFB, California. This plan is intended to apply to SAIC, subcontractors to SAIC, and employees of other firms working under the technical direction of SAIC at the site of the investigation. It has been prepared in recognition of and is consistent with the 1 December 1983 Contractor Safety Plan as prepared by HQ, 831st Air Division (TAC) at George AFB. A copy of the USAF Safety Plan is attached.

1.2 WORK DESCRIPTION

The work to be performed will determine whether or not environmental contamination has resulted from waste disposal practices at George AFB, California and should contamination be found estimates of the magnitude and extent of the contamination will be provided.

1.3 TECHNICAL EFFORT

A magnetometer survey will be performed in the Southeast Disposal Area (Sites L-1, L-2, M-2, L-3). The results of this investigation will be used to locate the three downgradient monitoring wells to be installed.

Three groundwater monitoring wells shall be installed hydraulically downgradient of the Southeast Disposal Area. The exact locations of the wells shall be determined from the results of the magnetometer survey. Standard penetration tests and split spoon sampling shall be done as borings are made. Monitoring wells will be installed in the borings. Wells will be developed, water levels measured and water samples shall be taken.

Groundwater samples from the northeast and southeast disposal areas shall be analyzed for oils and greases, phenols, total organic carbon (TOC), chromium, lead, silver, purgeable halocarbons, purgeable aromatics, DDT and chlordane. Water samples taken from the central disposal area monitoring well shall be analyzed for oils and greases, TOC and polychlorinated biphenyls. All soil samples will be analyzed for oils and greases.

1.4 ACCIDENT PREVENTION

All on-site project personnel will read and maintain a copy of this safety plan and safety precautions. All on-site personnel will be instructed as to avoidance of recognized hazards prior to beginning work on the job site. Safety meetings will be held to identify and evaluate possible hazards and problems before the start of work.

SAIC corporate policy B-19-1 states:

> "The personal and collective safety and health of all employees of this company is of primary importance. The prevention of occupationally

(work-related) caused injuries and illnesses is of such consequence that it shall be given precedence over operating productivity.

"Safety shall be practiced by all personnel at all times. Only safe methods and equipment shall be used.

"It is the company's intent to always maintain effective standards for guarding against injuries and illnesses while on the job. To be successful, proper attitudes toward the prevention of injuries and illnesses on the part of all employees is required. Success in all safety and health matters also depends upon cooperation among the company, its supervisors, and all employees, and also between each employee and fellow workers. Only through such cooperative attitudes and efforts can a safety record in the best interest of all be established and preserved.

"Our safety and health program is designed to reduce the number of injuries and illnesses to a minimum. Our goal is zero accidents, injuries and illnesses."

In an effort to protect our employees the following standards will be met:

- All employees shall follow safe practices, use personal protective equipment as required, render every possible aid to safety operations, and report all unsafe conditions or practices.

- Work shall be well planned and supervised to prevent injuries.

- All employees shall be given frequent accident prevention instructions.

- Supervisors shall insist on employees observing and obeying every rule, regulation, and order as is necessary for the safe conduct of the work.

- All unsafe, unhealthy, or hazardous conditions or places shall be immediately placed off limits, out of order, etc., and then promptly removed or corrected.

- No one shall knowingly be permitted or required to work with impaired ability or alertness caused by fatigue, illness or other factors such that the employee or others may be exposed to accidents or injury.

- No one will be allowed on the job while under the influence of intoxicating liquor or drugs.

- Horseplay, scuffling and other acts which have or tend to have an adverse influence on the safety or well-being of employees are prohibited.

- Crowding or pushing when boarding or leaving any vehicle or other conveyance is prohibited.

- Employees shall be alert to see that all guards and other protective devices are in their proper places and adjusted to operation equipment and shall report deficiencies promptly.

- Workers shall not hand e or tamper with any tools, equipment, machinery, or facilities not within the scope of their duties, unless they are thoroughly qualified and have received instructions from their supervisor.

- All injuries shall be reported promptly, so that arrangements can be made for medical or first-aid treatment.

- When lifting heavy objects, use the large muscles of the leg instead of the smaller muscles of the back.

- When involved in activities such as welding, carpentry, etc., protect the eyes at all times through the proper use of goggles, hoods, etc.

- Know where you are going and how you are going to get there. Look before you move.

- Watch out for others; they may not be aware of what you are doing or where you are going.

- Wash thoroughly after handling injurious or poisonous substances, and follow all special instructions from authorized sources. Hands should be thoroughly cleaned just prior to eating.

- Loose or frayed clothing, dangling ties, finger rings, etc., shall not be worn near moving machinery or other sources of entanglement.

- Apparatus, tools, equipment and machinery shall not be repaired or adjusted while in operation, nor shall oiling of moving parts be attempted, except on equipment that is designed or fitted with safeguards to protect the person performing the work.

- Use common sense. If you do not know, don't do it.

1.5 OBSERVANCE OF USAF REGULATIONS

SAIC and its subcontractors will observe and cooperate with all base regulations regarding access, vehicle operation, personal conduct, etc. while on base. Specifically: (1) all personnel will obtain passes to enter base property and will check in and out through base guard stations, (2) all vehicles used on site will carry current registration and inspection information, and (3) all vehicle/equipment operators will carry valid driver/operator licenses.

1.6 SANITATION

Drinking water will be obtained from local culinary sources and dispensed from cooler cans and disposable paper cups. Every effort will be made to establish and maintain sanitary job conditions.

1.7 FIRST AID AND MEDICAL FACILITIES

SAIC and its subcontractors will have available first aid kits for treatment of minor injuries. All on site project personnel will be made familiar with the location and instructions to the nearest emergency medical care facility should emergency treatment be required.

1.8 ACCIDENT REPORTING

Accidents will be reported within one hour. All required accident report forms will be promptly completed.

2.0 SAFETY PRECAUTIONS

2.1 MAGNETOMETER SURVEY

A. Only qualified personnel with related field experience will be used for this work.

B. All drivers will have a valid driver's license.

C. Personal clothing standards will be enforced. Minimum requirements are listed below.

1. Short sleeve shirt
2. Long trousers
3. Leather boots or work shoes or other appropriate protective shoes or boots. Canvas shoes, tennis or deck shoes are not acceptable.
4. Hard hats are optional since this is not a construction activity and will not take place in construction areas.

D. The field crew chief or geophysicist in charge on the site will be the job site safety officer and will be responsible for crew safety.

E. All personnel will be familiar with the location of the nearest emergency medical facility as well as direct routes to that facility.

2.2 DRILLING ACTIVITIES

A. Only qualified personnel with related field experience will be used for this work.

B. All drivers will have a valid driver's license.

C. Personal clothing standards will be enforced. Minimum requirements are listed below.

1. Short sleeve shirt
2. Long trousers
3. Safety toe leather boots or work shoes or other appropriate protective shoes or boots. Canvas shoes, tennis or deck shoes are not acceptable.
4. Hard hats will be required since this is a construction activity and will take place on and around overhead heavy equipment.
5. Hearing protection in the form of either disposable foam earplugs, reusable rubber earplugs or earmuff type noise attenuators.

D. JRB's field geologist or project manager will be on site and will be the job site safety officer responsible for crew safety.

E. All personnel will be familiar with the location of the nearest emergency medical facility as well as direct routes to that facility.

2.3 WELL DEVELOPMENT AND FLUSHING ACTIVITIES

2.3.1 Safety Training

Persons designated to develop and flush monitoring wells will be instructed regarding the potential health and safety hazards associated with the work prior to commencing field activities. Specifically, the following topics will be covered in the training session:

A. Potential routes of contact with toxic and/or corrosive substances.

1. Skin contact/adsorption
2. Eye contact
3. Inhalation
4. Ingestion

B. Types, proper use, limitations and maintenance of applicable protective clothing and equipment.

1. Safety helmet
2. Hearing protection
3. Chemical goggles
4. Impervious/chemical resistant gloves
5. Impervious/chemical resistant safety-toe boots
6. Impervious body coverings (aprons, blouse, trousers)

C. Respiratory protection using half-facepiece air purifying respirator with replaceable filter cartridges.

1. Hierarchy of protective controls: engineered, administrative, work practice, personal protective clothing and equipment.
2. Forms of respiratory protection: air purifying (disposal/reusable), air supplied, self contained.
3. Selection of respiratory protection based on hazard: dust, fume, mist, gas, irritant, poor warning properties.
4. NIOSH certification/approval of respiratory protection equipment.
5. Medical/physical fitness to wear respiratory protection.
6. Reporting of accidents and availability of medical assistance.

2.3.2 Protective Clothing and Equipment

All development and/or flushing of monitoring wells will be performed by persons garbed in the following minimum protective items:

1. Long sleeve shirt
2. Long trousers
3. Leather boots, work shoes or other appropriate protective shoes or boots. Canvas shoes, tennis or deck shoes are not acceptable.
4. Hearing protection in the form of either disposable foam earplugs, reusable rubber earplugs or earmuff type noise attenuators when using generators or compressors.
5. Impervious/chemical resistant gloves shall be worn when hand-bailing monitoring wells.
6. Hard hats are optional since this is not a construction activity and will not take place in construction areas.

2.3.3 Work Practices

All development and/or flushing activities will be conducted by persons wearing at least the minimum protective items listed above.

Field personnel will stand upwind from discharge ports or hoses when using mechanical methods of development and/or flushing.

Odorous water conditions will result in donning of organic vapor/acid gas respiratory protection.

All equipment used in well development and/or flushing will be cleaned and rinsed with fresh water before being used in another well.

No food will be consumed at the well site. Field personnel must wash thoroughly after participating in well development and/or flushing activities. Hands and face should be thoroughly cleaned just prior to eating.

2.4 COLLECTION AND HANDLING OF SPLIT SPOON SAMPLES AND/OR DRILLING SAMPLES

2.4.1 Safety Training

Persons designated to collect or handle split spoon soil samples will be instructed regarding the potential health and safety hazards associated with the work prior to commencing field activities. Specifically, the following topics will be covered in the training session:

A. Potential routes of contact with toxic and/or corrosive substances.

   1. Skin contact/adsorption
   2. Eye contact
   3. Inhalation
   4. Ingestion

B. Types, proper use, limitations and maintenance of applicable protective clothing and equipment.

   1. Safety helmet
   2. Chemical goggles
   3. Impervious/chemical resistant gloves
   4. Impervious/chemical resistant safety-toe boots
   5. Impervious body coverings (aprons, blouse, trousers)

C. Respiratory protection using half-facepiece air purifying respirator with replaceable filter cartridges.

   1. Hierarchy of protective controls: engineered, administrative, work practice, personal protective clothing and equipment.
   2. Forms of respiratory protection: air purifying (disposal/reusable), air supplied, self contained.
   3. Selection of respiratory protection based on hazard: dust, fume, mist, gas, irritant, poor warning properties.
   4. NIOSH certification/approval of respiratory protection equipment.
   5. Medical/physical fitness to wear respiratory protection.

D. Reporting of accidents and availability of medical assistance.

2.4.2 Protective Clothing and Equipment

All sample collection work will be performed by persons garbed in the following minimum protective items:

1. Long sleeve shirt
2. Long trousers
3. Chemical resistant/impervious boots
4. Gauntlet style, chemical resistant/impervious gloves
5. Chemical eye goggles or face shield

Depending on soil or groundwater properties, site conditions and weather, other items may be used for supplemental protection. Such items may include:

1. Respiratory (half-facepiece, air purifying)
2. Impervious apron
3. Impervious work blouse and/or trousers

2.4.3 Work Practices During Sampling

All sampling activities will be conducted by persons wearing at least the minimum protective items listed above.

Field personnel will stand upwind from the sampling location and upwind from extracted samples during their handling.

Odorous soil, water or site conditions will result in donning of organic vapor/acid gas respiratory protection. Similarly, dusty site or soil sample conditions will result in donning particulate filter type respirators.

Soil or water samples which display contamination will be removed from the site in suitable sealed sample containers for analysis and eventual disposal.

Sample containers will be resistant to solution and breakage, and they must have a leakproof seal. If any of these conditions are not satisfied, the container should not be used.

Reagents used for sample preservation and solvents used for cleaning bailers, etc. shall be stored in approved clearly labelled containers with appropriate warning labels.

Pipettes used for delivery of reagents for sample preservation shall be dedicated to specific reagents and must be cleaned and rinsed before storage after sampling.

No food will be consumed at the well site. Field personnnel must wash thoroughly after handling caustic, acidic, corrosive or hazardous substances. Personnel shall follow all special instructions on decontamination from authorized sources. Hands and face should be thoroughly cleaned just prior to eating.

2.4.4 Equipment, Personal and Site Hygiene

Punctured, internally contaminated, cracked, stubbornly soiled, protective items will be disposed of in sealed plastic bags.

Paper, rags, and other disposables used on site or in equipment/sample container clean up will be disposed of in sealed plastic bags.

Gloves, boots, other protective coverings and sampling equipment will be rinsed with clean water at the site before eating, drinking and at the conclusion of each day's activities. Respirators, if worn, will be used during the rinse down activity.

Where visual observation of cuttings or detected odors show contamination, personal protective items will be placed in clean bags after rinsing for transportation to an area where they can be thoroughly cleaned with detergent and water and inspected for leaks, cracks or other damage. Where only clean cuttings are present, protective items will be rinsed, inspected, dried and otherwise made ready for reuse. Respirators will be thoroughly cleaned, disinfected and repaired after each use.

Drill cuttings which display odor or visual contamination will be sampled for laboratory chemical analysis. Ultimate disposal of the cuttings will be based on chemical analyses.

Odorous soil cores or site conditions will result in donning of organic vapor/acid gas respiratory protection. Similarly, dusty site or drill cuttings will result in donning particulate filter type respirators.

Soil cuttings from well drilling which display contamination will be removed from the site in suitable sealed containers or drums for eventual disposal, or placed back into the borehole.

No food will be consumed on the drilling site. Employees will thoroughly wash their hands, forearms and face before consuming food or beverages other than water held in disposable cups. Drinking water will be available at the perimeter of the site being investigated. Disposable cups will be used to consume water after protective gloves are removed.

2.5 PIPELINE EXFILTRATION STUDY ACTIVITIES

2.5.1 Safety Training

Persons designated to perform the industrial pipeline exfiltration study will be instructed regarding the potential health and safety hazards associated with the work prior to commencing field activities. Specifically, the following topics will be covered in the training session:

A. Potential routes of contact with toxic and/or corrosive substances.

1. Skin contact/adsorption
2. Eye contact
3. Inhalation
4. Ingestion

B. Types, proper use, limitations and maintenance of applicable protective clothing and equipment

1. Safety helmet
2. Chemical goggles
3. Impervious/chemical resistant gloves
4. Impervious/chemical resistant safety-toe boots
5. Impervious body coverings (aprons, blouse, trousers)
6. Hearing protection

C. Respiratory protection using half-facepiece air purifying respirator with replaceble filter cartridges.

1. Hierarchy of protective controls: engineered, administrative, work practice, personal protective clothing and equipment.
2. Forms of respiratory protection: air purifying (disposal/reusable), air supplied, self contained.
3. Selection of respiratory protection based on hazard: dust, fume, mist, gas, irritant, poor warning properties.
4. NIOSH certification/approval of respiratory protection equipment.
5. Medical/physical fitness to wear respiratory protection.
6. Reporting of accidents and availability of medical assistance.

2.5.2 Protective Clothing and Equipment

All pipeline exfiltration study activities will be performed by persons garbed in the following minimum protective items:

1. Long sleeve shirt
2. Long trousers
3. Leather boots, work shoes or other appropriate protective shoes or boots. Canvas shoes, tennis or deck shoes are not acceptable.
4. Hard hats are optional since this is not a construction activity and will not take place in construction areas.
5. Hearing protection in the form of either disposable foam earplugs, reusable rubber earplugs or earmuff type noise attenuators when on the flight line.

2.5.3 Work Practices

Most manholes are shallow (i.e., less than five feet deep) and oxygen limitations are not anticipated. However, no more than one person is allowed within the manhole and two people will remain near the manhole ring to extract the down hole person in the event of an emergency.

NO SMOKING is allowed on the flight line and/or adjacent to the pipeline.

Odorous water conditions will result in donning of organic vapor/acid gas respiratory protection.

All equipment used in pipeline exfiltration study activities will be cleaned and rinsed with fresh water before being reused.

No food will be consumed at the pipeline site. Field personnel must wash thoroughly after participating in pipeline exfiltration study activities. Hands and face should be thoroughly cleaned just prior to eating.

831st AIR DIVISION SAFETY

GEORGE AFB, CA

BEST IN THE WEST

CONTRACTOR SAFETY

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS 831ST AIR DIVISION (TAC)
GEORGE AIR FORCE BASE, CA 92392

REPLY TO ATTN OF: SE (2920) 1 Dec 1983

SUBJECT: Contractor Safety

TO: Construction and Maintenance Contractors

1. The United States Air Force expends large sums of money to protect the safety and welfare of its personnel and to prevent damage to material and property with which it is entrusted. The Air Force is also interested in the safety and welfare of those who perform services for the Air Force in any manner and desires that their safety and welfare be provided for as adequately as that of its own personnel.

2. Obviously, such objectives can be attained only by the cooperation of all concerned. Therefore, it is requested that your activities on this air base conform with the accepted safety practices at all times.

3. The following is furnished for your general information and guidance and is in no way intended to be all-inclusive.

4. While you are performing your contract, your work site will be subject to visits by representatives of the 831AD Safety Office as well as compliance officers representing the Department of Labor, Occupational Safety and Health Office (OSHA) and California Occupational Safety and Health Office (CalOSHA). The objective of these inspections is to insure that generally accepted safety practices are being complied with and all applicable safety, fire, and health regulations are being adhered to while accomplishing the job.

5. Every contractor and subcontractor will protect the safety and health of employees. No work will be performed in buildings or surroundings which are unsanitary, hazardous, or dangerous to the health and safety of employees. Ensure that personal protective equipment (PPE) applicable to the contract is available, serviceable and correctly used by all employees.

a. U.S. Army Corps of Engineer Manual EM 385-1-1, applicable Air Force Occupational Safety and Health (AFOSH) directives, the Occupational Safety and Health Act (OSHA), and the California Occupational Safety and Health Administration (CAL OSHA) - Title 8, establish safety regulations and procedures which will be followed by contractor personnel while performing work for this base. Copies of these publications are available for review at the following offices: Contracting, Civil Engineering, U.S. Army Corps of Engineering, and the Base Ground Safety Office.

b. Base traffic regulations will be observed by all contractor personnel. Safety belts are required to be worn by all occupants of privately owned and company owned vehicles while thay are on George AFB property. This requirement applies to vehicles that were orginally factory equipped with seat restraints. Information regarding such regulations may be obtained from a representative of the Chief, Security and Law Enforcement.

Readiness is our Profession

c. Contractor personnel will not operate any type of vehicle on the flightline without approval of the contracting offfcer or his authorized representative.

d. All excavations, trenches, open manholes, etc., will be properly barricaded and will be lighted during hours of darkness.

e. Unauthorized personnel will not be allowed to enter the contractor's work area when such action could result in exposure to mishap potentials.

f. Contractor personnel will not enter manholes to perform work until such entry has been approved by the contracting officer or his authorized representative.

g. Temporary electrical wiring will be maintained in such condition and run in a manner which will not constitute an electrical hazard to personnel or a fire hazard to property. Use the national electrical code for guidance.

h. Powder actuated tools will be used only by contractor personnel who have been certified as having adequate knowledge for safe use of these tools.

i. Contractor personnel will not smoke in areas where such actions would constitute a fire and/or explosion hazard and will in no instance smoke within fifty feet of liquid fuels, parked aircraft or liquid oxygen storage.

j. Contractors will not store or use explosives on this base without prior consent of the Explosive Safety Officer, base extension 2922. (This requirement does not pertain to a reasonable amount of ammunition for use in powder actuated tools).

k. Internal combustion engines will not be operated in areas where such operation will create a fire or explosive hazard.

l. Contractors will not leave roofing materials on roofs of inhabited buildings unless prior authority has been obtained from the Air Force Contracting Officer.

m. Contractors working in the vicinity of aircraft will secure construction materials and equipment in such a manner that aircraft will not be damaged in the event of a windstorm, fire or other similar circumstances.

n. Compressed gas cylinders used by contractors will be properly secured during use and storage, and will be stored in an area which is not accessible to unauthorized personnel.

o. Flammable liquids will not be stored in any building except buildings so designated for flammable storage. Supplies of flammable liquids will be kept in approved safety cans with the name of contents stenciled on the containers. Gasoline powered machines will not be refueled while the engine is running or inside any building.

p. Every contractor or subcontractor will maintain records of all work related injuries to employees, including a brief discription of the mishap occurrence, date and duration of disability.

q. The contractor will obtain a welding permit from the Base Fire Department prior to performing any welding or cutting operations. The Fire Department will provide a briefing on required extinguishing equipment needed and standby fire watchers for hazardous areas.

6. The 831st Air Division Safety Office is located in Building 283, Room 4. Our phone numbers are: (Commercial) 269-2920/2923. Should a question arise or a problem occur which requires our assistance please do not hesitate to call or stop by our office.

Earl L. Pannebaker

EARL L. PANNEBAKER, GS-11
Chief, Ground Safety

APPENDIX K

BIOSKETCHES OF KEY PERSONNEL

RICHARD W. GREILING

EDUCATION

University of Wisconsin, B.S., Industrial Engineering (1973)
University of Wisconsin, M.S., Sanitary Engineering (1975)
University of Wisconsin, M.S., Water Resources Management (1975)
University of Washington, Cold Regions Engineering (1980)

PROFESSIONAL ENGINEERING REGISTRATION

Alaska (CE-4940), Arkansas (CE-5794), Nevada (CE-6569), Washington (CE-17737), and Wisconsin (CE-18130)

PROFESSIONAL EXPERIENCE

Principal Investigator for the field confirmation and preparation of the Phase I Records Search at Shemya AFB, Alaska, Malmstrom AFB, Montana, and Fairchild AFB, Washington, and the Phase IIa Presurvey Reports for Clear AFS, Alaska and McChord AFB, Washington. The projects included site survey of all hazardous waste disposal practices, including the examination of the storage, transfer, use, and disposal of aviation fuels, solvents, lubricants, and other petroleum products; and a technical project work assignment and cost estimate to conduct intensive site investigations.

Project Manager for site investigations in Phase II of the Installation Restoration Program (IRP) at McChord Air Force Base, Washington. To date the project has resulted in the siting and development of more than 30 groundwater monitoring wells and more than 22,000 linear feet of seismic refraction transects and more than 25 electrical resistivity stations to assist in the geologic interpretation of subterranean impermeable features which may serve as an aquitard between two shallow aquifers.

Project Manager for IRP Phase II site investigation at Kingsley Field, Oregon. The field investigation includes geophysical surveys across abandoned landfills to determine the location and areal extent of suspected buried chemical wastes in steel drums, boring and development of groundwater monitoring wells, and soil and groundwater chemical characterization.

Project Manager for the performance of RCRA Section 3012 preliminary assessments at 400 potential hazardous waste disposal sites in Washington State. The project entails the records search of local, state and federal regulatory and resource management agencies, on-site surveys, and interviews of owner/operators and adjacent property owners for the purposes of identifying the potential risks associated with past and current hazardous waste management practices.

Served as Project Manager in a feasibility analysis and impact assessment for long-term disposal strategies for hazardous wastes in the State of Alaska. The study includes integrating treatment, storage and disposal (TSD) information from RCRA permit applicants, and small generator data from an industrial inventory and survey with historical data on abandoned waste disposal sites across the state.

JOHN M. MUSSER, JR.

EDUCATION

B.A., Geology, University of Colorado, 1958
Graduate Study in Mathematics, University of Washington

PROFESSIONAL REGISTRATION & CERTIFICATION

State of California: Registered Geologist, Certified Engineering Geologist

PROFESSIONAL BACKGROUND

After graduating from the University of Colorado, Mr. Musser entered graduate school at the University of Washington to continue education in mathematics. In 1960 he was employed full time as a land surveyor for Harstad & Associates where he became thoroughly familiar with survey techniques and methods working from chainman to instrument man, as a drafter, survey computer, instrument man and finally as a party chief.

In May of 1964 Mr. Musser joined Shannon and Wilson, Inc., as an engineering geologist to work on an investigation to determine the failure mechanisms in the Anchorage, Alaska area which had resulted from the Good Friday Earthquate of 1964.

Following this investigation, Mr. Musser joined Geo-Recon, Inc., as an engineering geophysicist. Geo-Recon, Inc. became part of Shannon and Wilson, Inc., in 1971. In 1979 he left Shannon and Wilson, Inc., and became one of the founders of Geo-Recon International.

Mr. Musser's expertise in seismic refraction and electrical resistivity techniques has contributed to many projects. He has experience in magnetics and has conducted a magnetic survey of a 45-acre closed sanitary landfill site. He also is experienced in ground penetrating radar operations in both overwater and ground modes of operation.

Mr. Musser has had extensive experience in overwater geophysical investigations. Among the projects in which he has developed a wide range of experience are an oil pipeline crossing study of the Strait of Juan de Fuca, numerous bridge crossings of Lake Washington and Puget Sound, a pre-lay survey of four power cable crossing sites, Wrangell, Alaska and numerous offshore gravel and outfall surveys. His operational capabilities include sidescan sonar systems, subbottom profiling devices, and location control systems, as well as expertise in overall project operations and management.

His expertise also includes measurement of compressional and shear wave velocities for dynamic moduli determinations for site response analysis. He has developed techniques and methods for downhole velocity measurements for siting studies for nuclear power plant site studies. He also participated in a study for the NRC to develop the overall behavior of soil under earthquake loading conditions. The latter program included approximately 20 400-foot boreholes located in California, Oregon, Washington and Alaska.

PATRICIA M. O'FLAHERTY

EDUCATION

University of Michigan: B.S., Natural Resources - Wildlife (1974)
Kent State University, Ohio: B.S., Biology - Natural Resources (1975)
University of Washington: 12 hours towards M.S., School of Forest Resources

PROFESSIONAL EXPERIENCE

Team Leader for IRP Phase I Records Search and Site Investigation at Shemya AFB, Alaska, and Malmstrom AFB, Montana. The projects entail records search of sites on the installation and at appropriate Federal and State offices, interviews of key personnel, and field reconnaissance of the installation of all hazardous waste disposal practices, storage locations, and transfer sites. The site survey included intensive examination of the POL system, landfill and prior dump sites, and base shops and power plant site.

Task Leader of a Preliminary Assessment Team conducting assessments of 400 Washington State hazardous waste storage or disposal sites in accordance with Section 3012 of the Resource Conservation and Recovery Act (RCRA). PA teams collect through records search, interviews, and site surveys all data relevant to the potential contamination risks associated with these sites. Factors included ground and surface water characteristics, the nature and quantities of waste materials, potential for containment or migration of these materials, and an assessment of the magnitude of potential or real impacts utilizing the Hazardous Ranking System (HRS) for each site.

Principal field technician for well sighting and installation for over 20 groundwater monitoring wells at McChord AFB Washington as part of a Phase II IRP Investigation. Field responsibilities included well development for chemical sampling, collection, storage, and transfer of sediment and water samples including volatile organics, phenols, cyanides, trace metals, and trace organics. Conducted routine collections of well data including water table depths, pH, conductivity, and temperature. Field technician at Kingsley Field, Oregon as part of a Phase II IRP Investigation. Collected water samples and prepared them for shipment to analytical laboratory.

Served as staff biologist and compiled all bird and fish data for a biological resource atlas and oil spill countermeasures atlas for a consortium of oil companies concerned with the Alaskan Beaufort Sea.

Served as staff biologist providing pertinent information on distribution of marine biota and assessed environmental effects for the Ocean Discharge Criteria Evaluation (ODCE) for southern California offshore oil exploration and development. Environmental effects of hazardous components of drilling muds, cuttings and produced waters were assessed with regard to their potential impact to this diverse and extensive marine community.

ROBERT L. PESHKIN

EDUCATION

Southampton College of Long Island University, B.S., Geology/Marine Science (1980)

PROFESSIONAL EXPERIENCE

Field geologist responsible for oversight of well drilling subcontractors and the collection and field interpretations of soil samples and groundwater flow features during site investigations for hazardous waste monitoirng activities in accordance with the USAF Installation Restoration Program (IRP) at McChord AFB, Washington and Kingsley Field, Oregon. Field project assignments have employed multiple drilling techniques and installation of monitoring wells at depths in excess of 200 feet. Field investigations have also employed the use of seismic refraction and electrical resistivity geophysical techniques over 20,000 linear feet of ground surface to define both groundwater table elevations and stratigraphic interfaces. Geohydrologic analyses were performed using field and geophysical data to determine groundwater movement, contaminant fluxes and boundaries, and rates of contaminant migration.

Project team member in the performance of 400 preliminary assessments of potential hazardous waste sites in Washington State in accordance with Resource Conservation and Recovery Act (RCRA) Section 3012. The project teams are conducting records searches, site surveys and interviews of owners/operators and adjacent property owners for the purpose of identifying and summarizing the potential risks associated with past and current hazardous waste management practices. Directly responsible for assessment of pollutant and leachate mobilization and migration, and environmental and health risks. Teams are assigning numerical ratings to all sites for data base profiling of hazardous waste site priority listing.

Field geologist and investigator with the IRP Phase I records searches at Malmstrom AFB, Montana, and Fairchild AFB, Washington. Specific assignments included the collection and interpretation of geohydrologic and geomorphologic data for regional and site specific quantification of known or suspected past hazardous waste pollutant sources, pathways, and receptors.

Data analyst at EPA Region X updating NPDES wastewater discharge permits. Responsible for interpreting and coding discharge limits into the National Permit Compliance System (a computer tracking system for discharge compliance and monitoring information). Also assisted Data Processing Center in solving problems in the data base.

Computer operator and monitor for a financial data processing firm. Technical responsibilities incorporate a variety of data base management skills such as data entry and retrieval, data sorting, creation of files, daily updating of data files, and data and file transfers. Also responsible for daily microcomputer maintenance troubleshooting.

GLYNDA JEAN STEINER

EDUCATION

University of Washington, B.S., Civil Engineering, March 1982
University of Washington, M.S., Civil Engineering, June, 1984

ENGINEERING CERTIFICATION

Engineer-in-Training (Washington)

PROFESSIONAL EXPERIENCE

Serves as an integral team member in hazardous waste monitoring activities in accordance with the U.S. Air Force Installation Restoration Program (IRP) at McChord AFB, Washington, Shemya AFB, Alaska, and Malmstrom AFB, Washington. Field assignments for the Phase I IRP include record searches, interviews of key personnel, and site investigations. Engineering evaluations focus on the use, storage, and disposal of hazardous materials associated with the operation of utilities, vehicle and equipment maintenance shops, and energy production facilities. Field assignments for the Phase II IRP include monitoring well installation, multiple well development techniques, groundwater sampling, and water quality analyses.

Serves as a project team member for the performance of preliminary assessments of 400 potential hazardous waste storage and disposal sites in Washington State in accordance with Section 3012 of the Resource Conservation and Recovery Act. Project assignments include record searches, site surveys, and interviews of owners/operators of storage and disposal sites and adjacent property owners for the purpose of identifying and summarizing the potential risks from these operations. Technical assessments include determination of the mobilization and migration of contaminants from these hazardous waste sites and the evaluation of the potential environmental and public health impacts resulting from these activities.

Developed municipal NPDES discharge permits with 301(h) variances for EPA Region IX. Plant design capacities ranged from 12 MGD to 120 MGD and include primary and secondary facilities. Technical assessments include development of an intensive monitoring program for both the wastewater and the receiving environment; and determination of effluent limits based on initial dilution of ocean water. These permits are among the first to be issued by EPA.

Serves as inspector in a nationwide contract calling for diagnostic evaluations and technical assistance to publicly owned treatment works (POTW) which have failed to achieve or presently are in noncompliance with the NPDES wastewater discharge limitations. The plant investigations are focusing on industrial and muncipal wastewater characterization, unit process performance and operations flexibility, process control, plant operations and maintenance, and operator staffing levels and training needs.

Principal investigator of a contract to update the NPDES effluent data in the Permit Compliance System (PCS) for EPA Region X. Responsibility included establishment of a coding format for NPDES effluent limits as they apply to permittees in Region X, correction of existing data base to be consistent with the aforementioned format, data entry, and PCS troubleshooting for the Region. Quality control and data accuracy was provided by retrieval and verification of entered data.

END

FILMED

11-85

DTIC